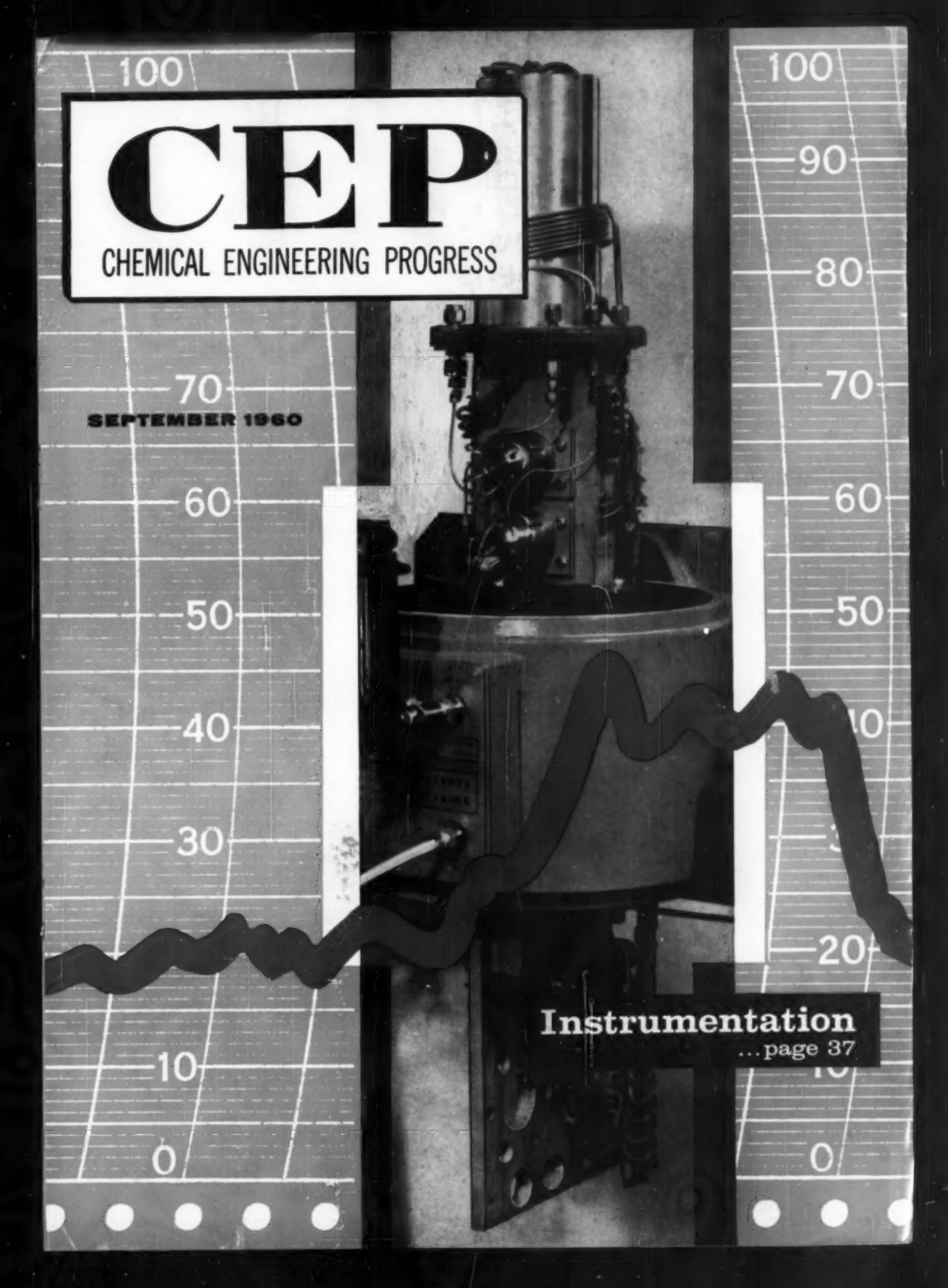

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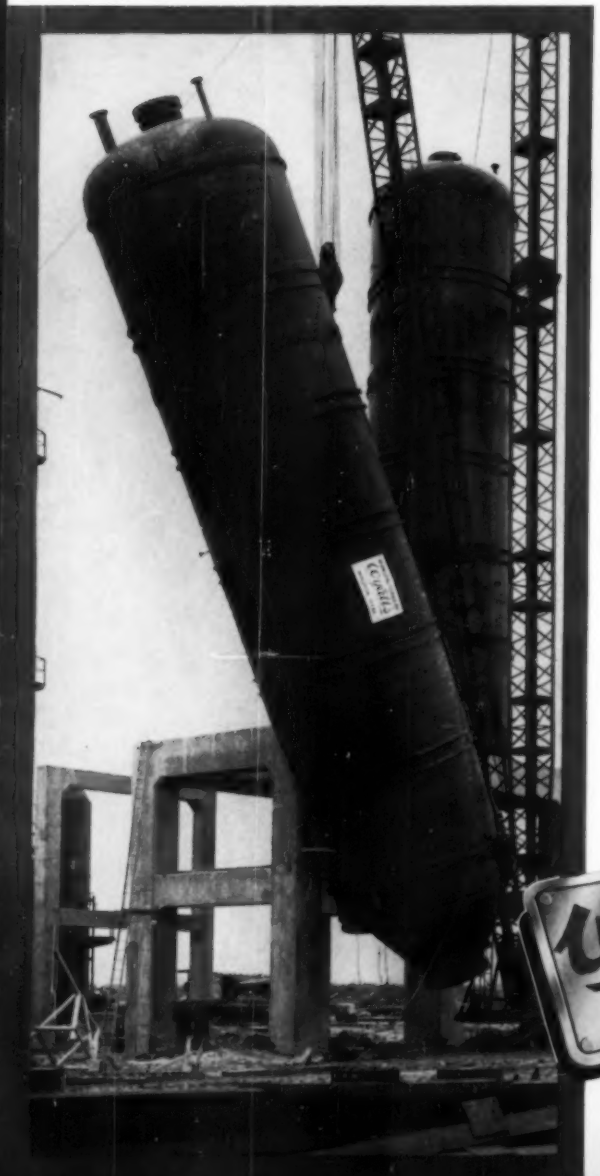


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book reviews

The general chemical technology of the Soviet Union

GENERAL CHEMICAL TECHNOLOGY (Obshchaya khimicheskaya tekhnologiya), S. I. Vol'fkovich et al., published by Goskhimizdat (State Scientific-Technical Publishing House for Chemical Literature), Moscow-Leningrad. Volume I, 1953, 632 pp.; Volume II, 1959, 848 pp.

It is to be hoped that in the relatively near future we will have in this country enough industrial chemists and chemical engineers who will have a sufficient knowledge of Russian to benefit from books of the kind under review here. The benefit would be threefold. (a) The USSR is rapidly developing its chemical industry and an attempt to follow up a process reported in the Russian periodical literature requires background information which is in many cases brought up to date in these books, especially in Volume II, although of necessity in brief summary. (b) Examination of textbooks provides an effective, even though a partial, answer to the question: how does the USSR train their technologists who have moved into the forefront of public interest in this country? (c) Another benefit, a purely professional one, is in satisfying the natural desire to see how the other half lives. For the last-mentioned use these books are suitable only when certain parts of them are studied with due caution.

The two volumes, written by experts in their various fields (six authors of Volume I and four authors of Volume II), some of whom are internationally known, and edited by Academician S. I. Vol'fkovich, make a pleasing impression. The improvement over an earlier edition (Volume I, 1940; Volume II, 1946) is striking. The present edition is distinguished by an expansion of the material, improved typography and a larger number of flow sheets (276 in Volume I; 262 in Volume II). Each of the two volumes was published in 25,000 copies, whereas the 1946 Volume II had an edition of only 10,000 copies. Good subject indexes are not to be taken for granted in Russian and other European books. The earlier edition of this work had an index totalling 15 pages for both volumes; this edition has adequate indexes comprising 12 + 30 = 42 pages.

This is not a work on chemical engineering in the American sense of the word, but an up-to-date and sufficiently detailed textbook of chemical technology and a reference work for use in industry and research. The amount of detail given in each chapter is meant to satisfy the specific needs in the USSR. The classification of the material is based on a combination of unit processes and raw materials or end use of products. Small deficiencies in presentation can be omitted from the discussion of this otherwise clearly and systematically written text.

The separation of the material into two volumes is not based on any apparent principle and was probably dictated by a desire to publish the first part of it as soon as it could be prepared. However, material of general character was naturally placed into Volume I. This includes a chapter on basic concepts, material and heat balances, a brief outline of process design and some related information, a 24 page discussion of principal physical and chemical regularities applicable to the subject, a chapter on raw materials, power and water supply in chemical industries. Attention of the student is called (Volume I, p. 28) to the economics of a chemical process and the need to appraise the cost of production. This subject is rather frequently discussed in the Soviet industrial literature. The concluding chapter of Volume II is devoted to bench and pilot plant research and plant design. There is also a well written chapter on the possible commercial utilization of radioactive products of fission of uranium.

This work adequately stresses the development tendencies of the Soviet chemical process industries. Explicit statements and sufficient references are given to some chemical processes recently featured in the Russian periodical literature. There are many references in Volume II to Russian publication dated 1957, a few even 1959. The bibliography for further study at the end of each chapter is selectively limited. Despite the extensive instruction in foreign languages in the USSR the references are to Russian publica-

continued on page 8



Technician with laboratory equipment at the Petroleum Instrument Laboratory in Leningrad. (Photo furnished by Dave Boyd, Universal Oil Products.)

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tions or translations into Russian; very few to work in other languages. On the other hand, it is natural for an author to quote publications best known to him and his audience.

The value of this work for chemical engineers, industrial chemists, and specialists in engineering education in this country can be shown by pointing out wherein it differs from standard works on chemical technology most frequently used by us.

The historical notes at the beginning of many chapters, and a special chapter in Volume I, survey the rise of the chemical technology and report early development of various industries in Russia, a subject which ought to be known better than it is now. However, the value of this material to an unbiased student is undermined by the commitments to the prevailing historical ideas in the USSR, and by the taboos imposed by considerations that have nothing to do with science or technology. As could be expected, these deficiencies are more prominent in Volume I than in Volume II, thus reflecting the difference in the political atmosphere in the USSR in 1953 as compared to 1959. The significance of Soviet contributions would be enhanced if due credit would always be given to non-Russian scientists.

An inconsistency of a different kind pertains to a number of Soviet innovations, as described in this work, and as reported in the Russian chemical literature. This may be due simply to the fact that some authors have brought their work up to date more than others.

It will be a vain effort to try and find reference to the late Professor V. N. Ipatieff's work in these volumes. This is a glaring omisson, if one considers what was contributed by V. N. Ipatieff and what was written about him in Russian publications before he left the USSR.

In recent years telomerization studied under the direction of the President of the Academy of Sciences, A. N. Nesmeyanov, and Professor R. Kh. Freĭdlina (Volume II, pp. 429-32) has led to the use of some of the products obtained, particularly, aminoenanthic acid forming a polyamide resin "enant" similar to nylon (ibid., p. 686). Commercial use of it is contemplated. I could not find a mention of Professor M. S. Kharasch of the University of Chicago in connection with telomerization, even though his publications on the sub-

continued on next page

ject are widely known. Similarly, it would probably not detract from the recognition of the successful work of B. D. Kruzhalov and P. G. Sergeev, who designed a plant for the production of acetone and phenol via isopropylbenzene and its hydroperoxide (Volume II, p. 508), if mention of similar research simultaneously pursued outside the USSR was made, although the process was first commercialized in the USSR.

Concerning the lack of up-to-date information on the state of the art, the case of butadiene manufacture should be mentioned. The drive to replace fermentation alcohol by synthetic ethanol or by butane-butylene as the starting material for the manufacture of butadiene has a history of many years behind it, and is apparantly succeeding now in the USSR. It has been included in official industrialization plans. However, in the discussion of this method (Volume II, pp. 402-4) one finds information to the effect that up to 80% of butadiene was produced in 1955 by dehydrogenation of C_4 hydrocarbons in the *USA*, but the extent of the use of this method in the USSR is not stated. To production of isoprene a page is devoted in Volume II (405-6), from which a reader will not be able to conclude that condensation of isobutylene with formaldehyde (the Prins reaction), followed by decomposition of the dimethyldioxane formed, has been studied on pilot plant scale since 1952 and is being commercialized now, which is known from the publications of M. I. Farberov in the Russian chemical journals.

In the chapter on ferrous metallurgy, a brief paragraph on the application of oxygen (Volume II, p. 156) speaks of the benefits to be obtained from it in the future, whereas a recent statement (Jan. 1960) by the late Academician I. P. Bardin* speaks of the application of oxygen in ferrous metallurgy as one of the most important innovations made in the last decade, and only stresses the need for fuller utilization of this innovation.

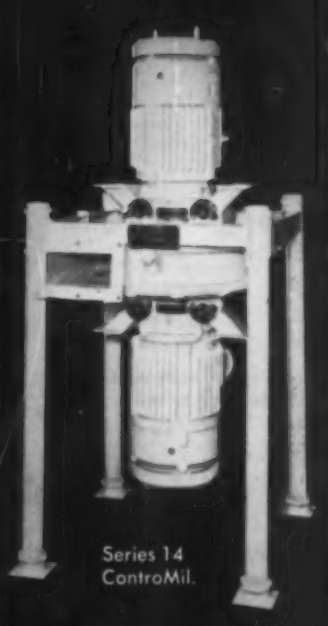
One cannot unequivocally assert that the apparent desire to give only the most pertinent references justifies

---

* *Izvestiya Akademii nauk SSSR, Otdelenie technicheskikh nauk (Metallurgiya i toplivo)* Bulletin of the Academy of Sciences, Department of Technical Sciences (Metallurgy and Fuel).

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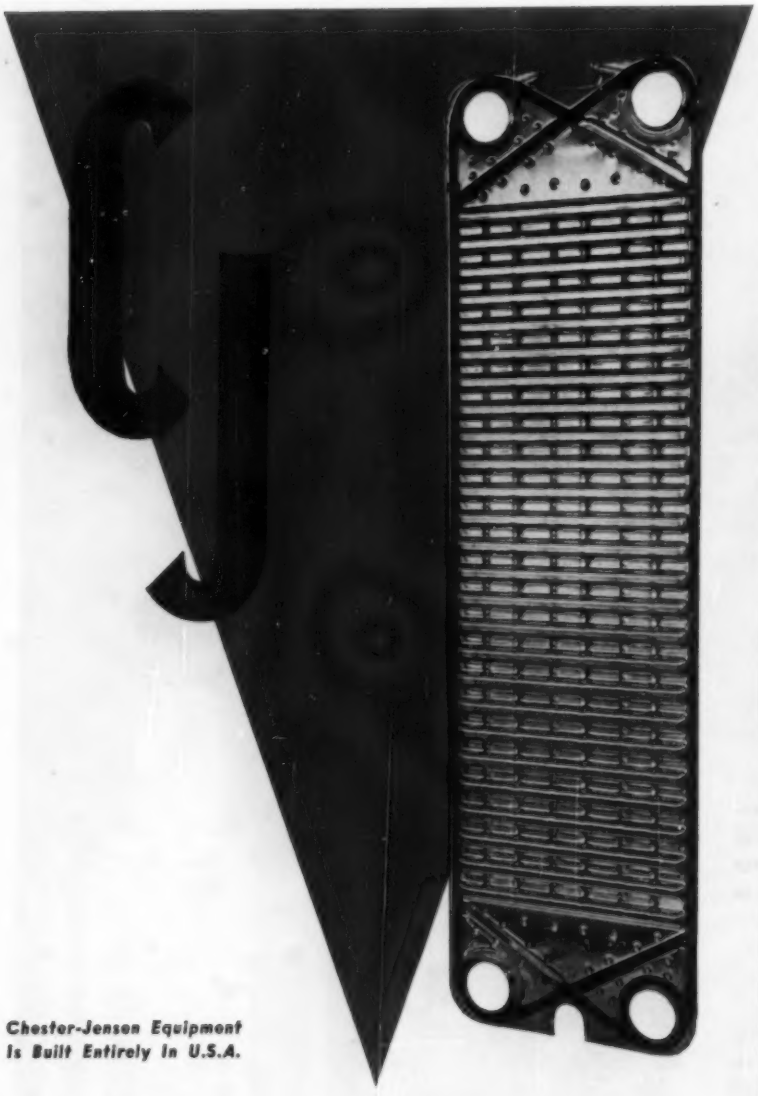
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these discrepancies, even if study of the literature references given would eventually lead to information filling the blanks. In the long range these drawbacks are likely to be a passing phenomenon, and the quality of the books merits wide use of them.

Reviewed by J. G. Tolpin, Research Dept., Standard Oil Co. (Indiana).

AUTOMATION, CYBERNETICS AND SOCIETY, F. H. George, Philosophical Library, Inc., 15 East 40th Street, New York 16, New York, 1959, 280 pages, plus index.

Popular words today are automation and cybernetics. A book which includes both of these words in its title clearly has promise of wide appeal. Unfortunately, the author in this case specifically excludes engineers from the people for whom the book is intended. The principal thesis of the book is that because of automation we are in a social revolution of such great import and such swiftness that our naturally slow biological evolution cannot keep pace. This fact, aggravated by the apparent lack of purpose in western man, makes it imperative that we rethink our plans for the future, and the manner in which we should evolve.

The organization of the book is somewhat disjointed, and the treatment throughout is uneven and largely superficial. Much of the last part is speculative and based on shaky presuppositions. Chemical engineers will find this book of insufficient value to warrant purchasing it, but after all it was not written for them.

Reviewed by Ernest F. Johnson, Princeton University, Princeton, New Jersey.

KINETICS OF HIGH TEMPERATURE PROCESSES, W. D. Kingery, John Wiley & Sons, Inc., New York, N. Y., (1959), 326 pp., $13.50.

LIQUIDS AND LIQUID MIXTURES, J. S. Rowlinson, Academic Press, Inc., New York, N. Y., (1959), 360 pp., $12.50.

ORGANIC SYNTHESES, Max Tishler, Editor-in-Chief, John Wiley & Sons, Inc., New York, N. Y., (1959), 114 pp., $4.00.

PHENOLIC RESINS, D. F. Gould, Reinhold Publishing Corp., New York, N. Y., (1959), 213 pp., $5.75.

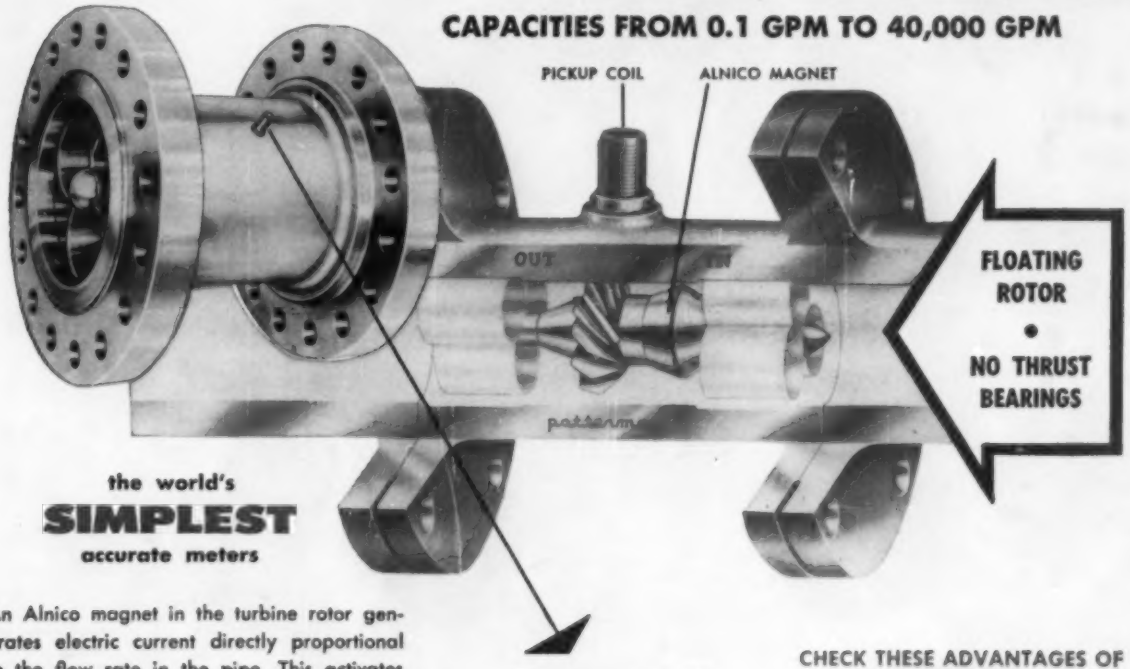
REGRESSION ANALYSIS, E. J. Williams, John Wiley & Sons, Inc., New York, N. Y., (1959), 214 pp., $7.50.

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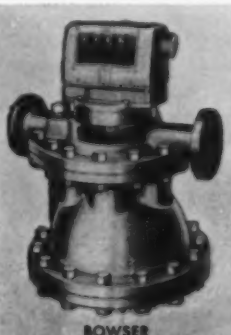
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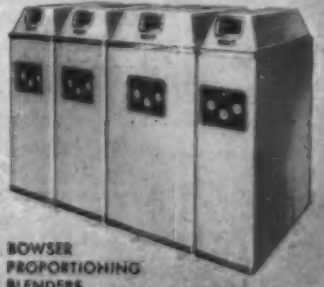


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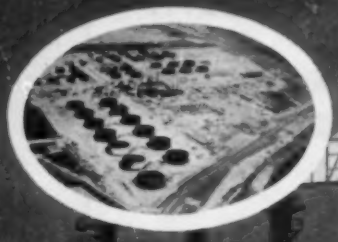
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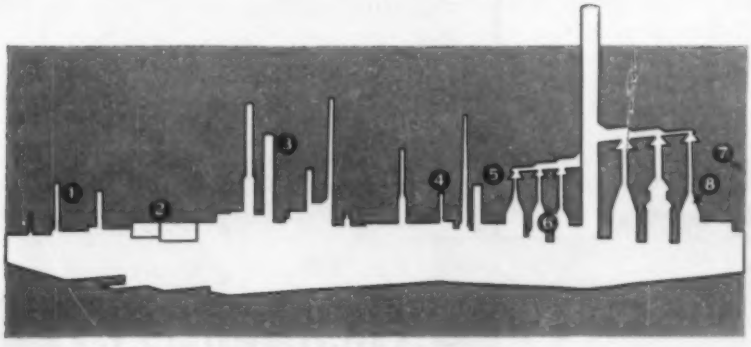
The work started, as most Dutch construction projects start, with "creating" land — 10 million yards of fill, supplied by the municipality of Rotterdam, were laced by more than 2000 piles, 80 feet long. On this underpinning Badger crews procured and erected the process units, storage tanks, waterfront and offsite facilities.

This refinery is another example of the reason why Badger and its overseas affiliates have established a world-wide reputation for making tough projects look easy. Whether you are thinking in terms of a small unit or major plant, it's the type of service you deserve. Please write or call for complete information on Badger services.

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The main process units of the Esso Nederland Refinery consist of ❶ Naphtha Stabilizer ❷ Crude Storage ❸ Crude Distillation ❹ Diesel Oil Hydrofiner ❺ Steam Plant and Water Treating Plant ❻ Powerformer ❼ Tanker, barge, rail and truck loading facilities ❽ Copper Chloride Treater. Blending Units are at right out of picture.

Waterfront facilities for the refinery cover 2260 meters and include two piers each capable of simultaneously handling a supertanker of up to 50,000 dwt.

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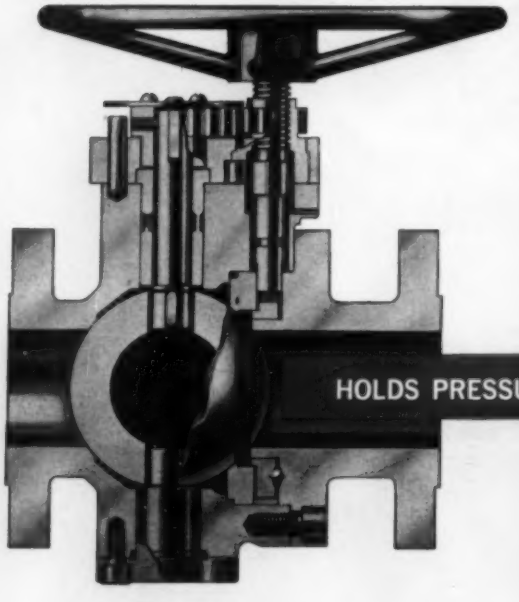
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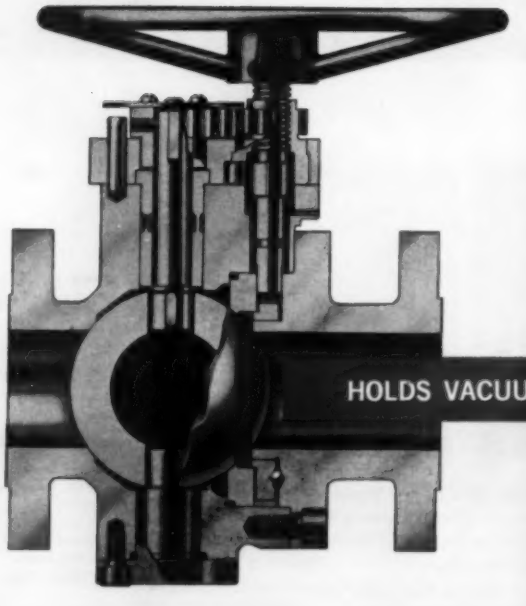
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Petrochem Show coming in New Orleans

A.I.Ch.E. Exposition-Meeting to be held February 26-March 1 will bring Petrochemical Show to the Gulf Coast, heartland of the petrochemical and refining industry.

THE PETROCHEMICAL AND PETROLEUM refining industries will soon see a major landmark. For the first time, a combination technical meeting and exposition will be held on a nationwide and industrywide basis: the A.I.Ch.E. Petrochemical and Refining Exposition. It takes place in conjunction with the 44th National Meeting of A.I.Ch.E. in New Orleans, February 26-March 1.

Spectacular strides made in both industries in recent years make such a gathering not only timely, but essential. Petrochemical production has jumped from 75 tons in 1927 to an estimated 25 million in 1960. Employment is now at 150,000 against the figure of 40,000 in 1948. Production of synthetic detergents, aromatic hydrocarbons, olefins, fluorochemicals, pesticides, synthetic fibers, plastics, and synthetic rubber are still growing. For the last decade, petrochemical production has grown at the rate of 14 percent a year. Volume has quadrupled. Overall capital expenditures are expected to reach $1.6 billion in 1960. Over 80% of all synthetic organic chemicals produced are accounted for by 300 different petrochemicals. Estimates put future expansion at up to 10% a year.

Companies with petrochemical plants in the Gulf Coast area are a real cross section of the chemical industry. These include: Allied Chemical, Celanese Corp., Chemstrand, Columbia-Southern Chemicals, Columbian Carbon, Diamond-Alkali, Dow Chemical, Du Pont, Esso Standard, Ethyl, Firestone, Goodrich Gulf Chemicals, Grace Chemical, Koppers, Monsanto, Phillips Petroleum, Rohm & Haas, Shell Chemical, Spencer Chemical, Stauffer, Union Carbide Chemicals.

A look at the refining industry is equally revealing. Total capacity is over 10 million bbl. crude oil/stream day. Of this, about 3.5 million is processed in the vital Gulf Coast area.

Crescent city location

The selection of New Orleans as site for the gathering is particularly fitting since its location in the heart of the Gulf Coast area puts it within a 400 mile radius of the heartland of the petrochemical industry. More than 85% of the petrochemical industry, and about one-third of the petroleum refineries, are in the Gulf Coast states. Converging upon New Orleans will be top chemical engineers, management, research and processing men from all over the country to take advantage of this opportunity to compare new developments, equipment and materials, and to hear the latest technical papers on the industries.

Because of the dynamic growth situation in the industry, the Exposition-Meeting, devoted solely to technological problems of the petrochemical and refining industries, has already attracted much attention. The attendance roster reads



like a Who's Who of Petrochemistry. The Meeting itself has the bulk of its papers covering material of interest to the entire industry. Against this background, the A.I.Ch.E. Petrochemical and Refining Exposition is sure to make a vital contribution to continued growth of both industries. Anyone interested in more information about the Exposition write to the Secretary, A.I.Ch.E., 25 West 45 Street, New York 36, N. Y., or to Reber-Friel Co., 117 S. 17th Street, Philadelphia 3, Pa. #

Dow expands at home and abroad

Agreement has been reached between Dow Chemical and Union Quimica del Norte de Espana (Unquinesa) to construct a petrochemical complex in Spain. Development plan calls for construction of a cracking unit to produce ethylene and propylene. The resulting C_4 fraction will be further processed to recover butadiene. Almost simultaneously, directors of Dow and Allied Laboratories have approved a merger of the two companies, subject to stockholder ratification.

Automatic control conclave in Moscow — a first-hand report

First full-scale meeting of the International Federation of Automatic Control assembles, in Moscow, 700 delegates from 26 countries, including 150 U.S. engineers.



The 30-story Ukraina Hotel where most of the delegates stayed in Moscow.

"Russia has definitely set automation—as complete as possible—as one of its national goals," says D.M. Boyd, summing up his impressions of the recent Meeting of the International Federation of Automatic Control, held in Moscow, June 27-July 2, 1960. Boyd, supervisor of Universal Oil Products' instrument group, attended the congress as official A.I.Ch.E representative.

The impetus behind this rapid development, believes Boyd, comes from top technical and managerial levels. The program appears to be aimed at leapfrogging the Russian shortage of skilled technicians by meeting the needs of "second generation" plants and processes with automatic control devices.

This first IFAC conference, which brought together some 700 delegates from 26 countries including 150 U.S. engineers, grew out of an earlier international gathering held four years ago in Heidelburg. This "pilot run" pointed up the feasibility of international technical cooperation, and IFAC was established to implement the plan.

U.S. participation is through the Automatic Control Council, which in turn is made up of delegates from A.I.Ch.E., the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Institute of Radio Engineers, and the Instrument Society of America.

Russian refinery visited

In what he believes to be the first American visit to a Russian refinery since Lend-Lease days, Boyd, during his stay in the Soviet Union, was invited to inspect a modern installation at Baku. He estimates the capacity of the Baku plant at about 100,000 BSD. Comparisons with U.S. refineries, he points out, are difficult to make because Russian production is geared to entirely different market requirements. They need, for example, a greater percentage of diesel and jet fuel than we do in the U.S.

The Baku installation, completed about three years ago, has three



Two famous names in the control field—Hans Sartorius of Germany (left) and Norbert Weiner of M.I.T. (right).



David Boyd, A.I.Ch.E. delegate, (right) presents scroll of congratulations to academician V.A. Trapeznkov (left).

catalytic cracking units (one fluid and two gas lift catalytic cracking) with catalyst manufacturing facilities, several thermal cracking units, and sulfuric acid alkylation and aluminum chloride isomerization units for gasoline production. Ethylene and propylene are piped to a nearby chemical plant, the products of which were not disclosed.

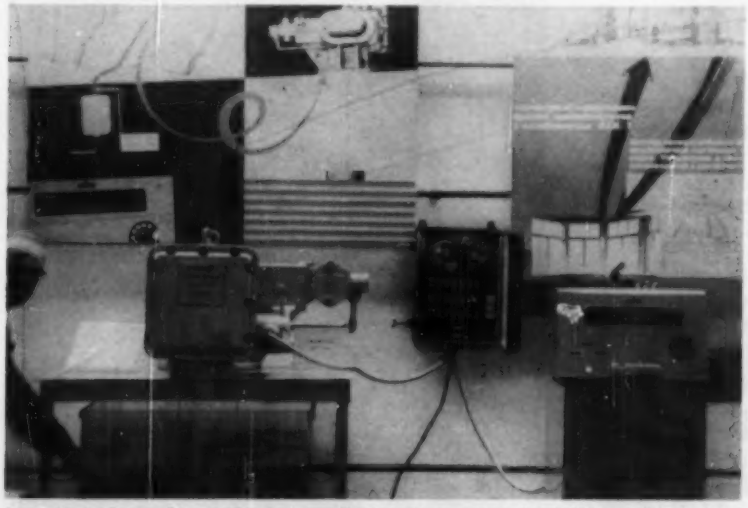
Controls and instrumentation appeared to be adequate for the refinery requirements. But further use of sophisticated controls can be expected to stem from work underway in the Leningrad development center, reports Boyd.

In these Leningrad facilities is centered research on instrumentation; special purpose and stream analysis instruments are being developed for the petroleum refining industry. Development activities currently include work on colorimeters, infrared analyzers, chromatographs, dielectric measurement and refractive index measuring devices. Quality of the instrumentation is difficult to assess, says Boyd, since none were in actual operation on processing units in either the Leningrad center or at the Baku refinery which he visited.

Instrumentation also occupies a prominent position in the exhibition of industrial and agricultural progress in Moscow. Covering some 600 acres, the exhibition is very much like a permanent world's fair. Here, the achievements and goals of Soviet industry and agriculture are showcased in 80 pavilions, each centered upon one activity. Together, they cover the gamut of Soviet economic life. The exhibition grounds are not only a lure for casual domestic and foreign visitors, but frequently are on the "must" itinerary of Russian managers and technicians visiting Moscow.



Opening of plenary session in the auditorium of the University of Moscow. IFAC meeting brought together about 700 delegates from 26 different countries.



Remote tank-gauging equipment on display at permanent exhibition of industrial and agricultural achievement near Moscow. Instrumentation occupies prominent place in exhibition.

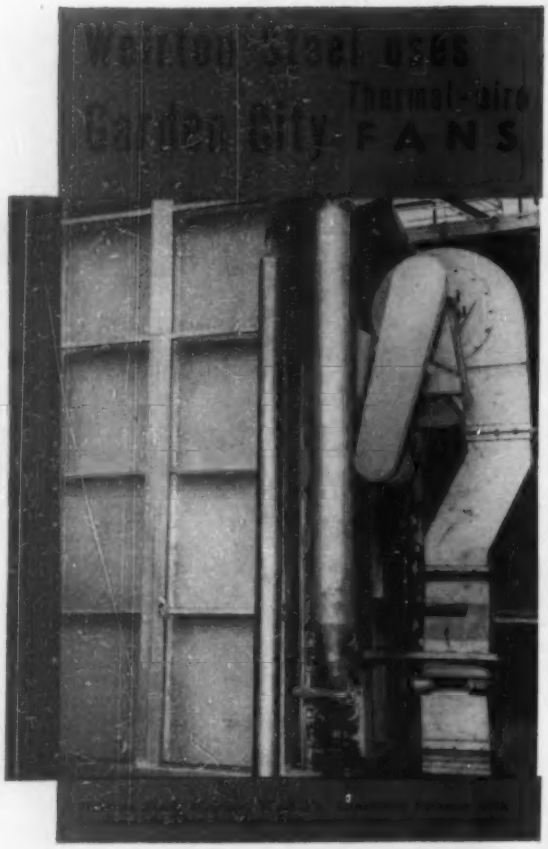
Displays within the petroleum pavilion spelled out details of modern methods that economic planners are urging on factory bosses. Instrumentation displays show much the same range of devices to be seen in the Leningrad development center.

Prefabricated tanks

One of the novel construction techniques illustrated with scale models is the erection of prefabricated storage tanks. Tank walls, reports Boyd, are apparently prefabricated and shipped in coils. On site, the coil is set on end on the tank bottom and unwound around a central structural member that supports a segmented roof, also apparently prefabricated.

Besides staffing the Moscow exhibition with conventional tourist guides, the Soviet government also provides engineers who can discuss specific details of the various displays with visiting Russian plant managers—and perhaps even inject a little sales effort to try and persuade the managers to adopt more automation in the facilities they supervise.

For a further photo report on the Moscow meeting, see CEP Camera, page 144.



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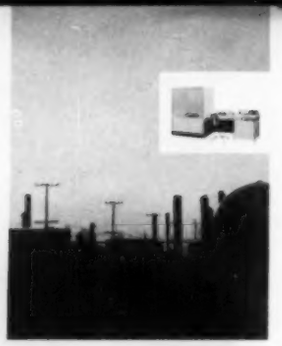
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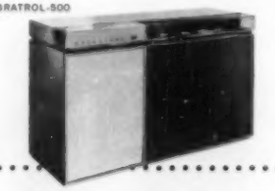
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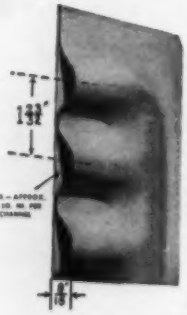
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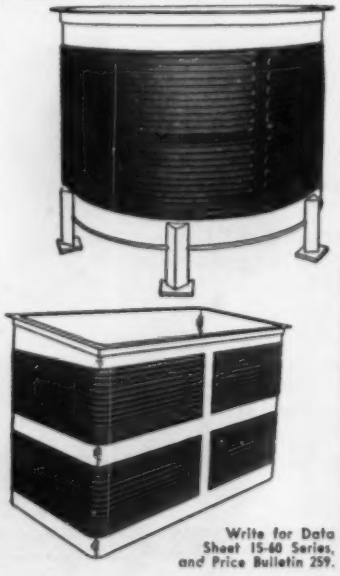
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Latin America and U. S. Industry

OPINION IN INFORMED Washington circles is sharply divided as to the probable long-term economic effects of the Cuban imbroglio on the rest of South and Central America, and even more at loggerheads as to what can, or should, be done about it.

Slow capital

One thing is fairly generally agreed on—win, lose or draw, the Cuban expropriations of foreign-owned industrial properties such as Freeport Sulphur's huge Moa Bay nickel plant, and the American and British-owned refineries, will tend to slow the flow of new investment capital into Latin America, may even bring it to a screeching halt as far as many private American firms are concerned. Certain analysts lean toward the view that the goals of Soviet and Red Chinese policy in Latin America are basically political rather than economic, that their support of Castro's government does not portend large-scale economic penetration, at least for the present, but is an effort to disrupt the political and economic life of the area for their own ends.

One other undeniable fact stands out in any analysis of the situation—South and Central America have vast natural resources which are inevitably going to be developed. Only question is—by whom and with what? The answer is of particular importance to the U.S. chemical industry with its present multi-million dollar commitments in the area, and its announced intentions for future development.

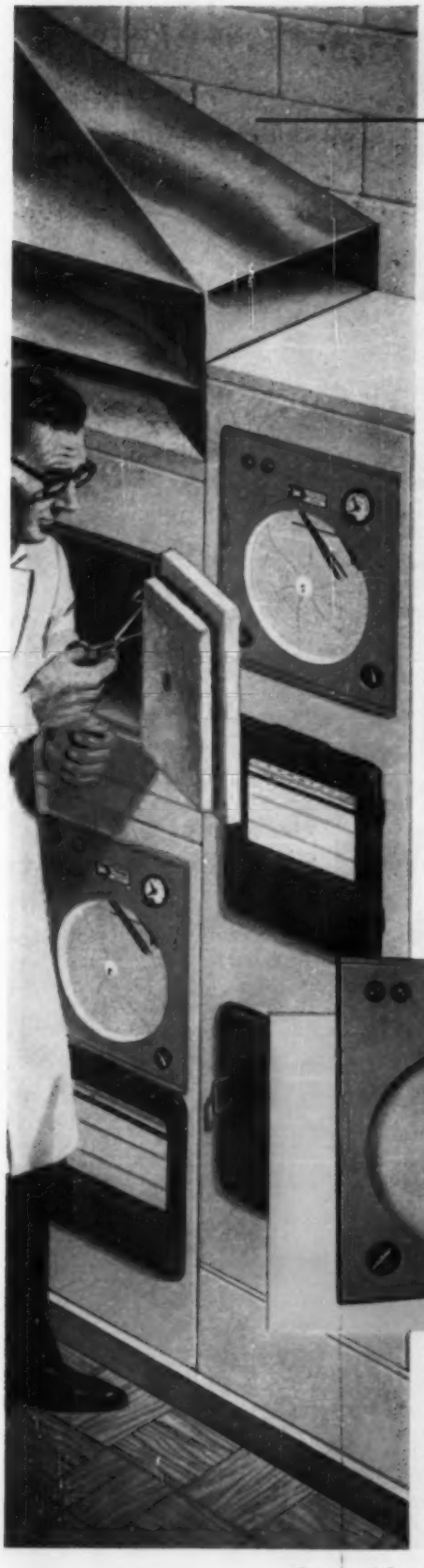
The facts of life

One school of thought in the capital holds that the U.S. should take the hard line, that is, should curtail economic aid to Latin America until the political situation is definitely stabilized. They feel that it is useless to pour money and resources into plants and equipment which are only going to be sitting ducks for future arbitrary expropriation, and which in the long run may even fall into the hand of interests inimical to the U.S. They point with misgiving to the fate of similar efforts on the part of the United States to stem the tide in Asia—Indochina is often cited as the horrible example.

A more middle-of-the-road group of expertizers, however, is less pessimistic. Burn no bridges, they urge, cooperate to the fullest extent with the Organization of American States, increase rather than decrease economic aid to Latin America, and hope for the best. Behind this point of view is the conviction that time can work for us as well as against us, that given a breathing spell, and sufficient economic aid to raise their standard of living appreciably, most of the countries of Latin America will turn out to be on our side. There are those in Washington, also, who maintain that, while no one can predict the future, the whole political and strategic line-up of the world could conceivably change almost overnight. They point, for example, to the persistent rumours of a serious parting of the ways between the Soviet Union and Communist China.

The third column

The Soviet bloc is not our only competitor for the industrial favors of Latin America. It is emphasized by some that a more serious threat to U.S. investment in that area may well be the increasing amount of European capital pouring into the continent—Italian, French, West German, British. Particularly in the chemical industry, such capital investment has been accompanied by technical aid, including equipment and European engineering missions. Those who view this economic threat seriously, maintain that to be stampeded by Castro into pulling up stakes in Latin America might only result in increased European infiltration which, while perhaps politically above reproach, could be as economically disastrous for U.S. interests as could Soviet or Chinese domination.



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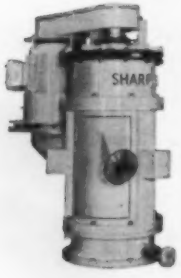
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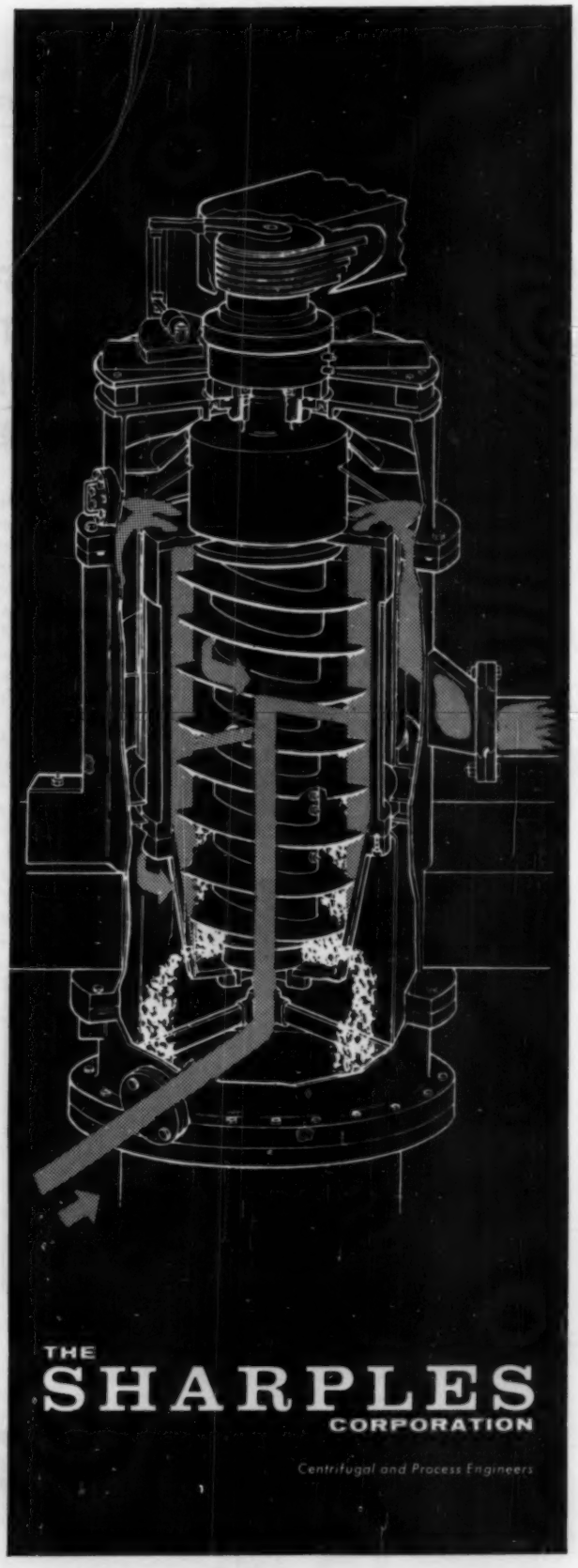
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These new gases are now available for prompt shipment in various cylinder sizes. The gases are described below, with specifications, chemical reactions and controls for handling.

Sulfur Tetrafluoride

Sulfur tetrafluoride is a colorless, reactive, highly toxic gas at room temperature and atmospheric pressure, with an odor resembling that of sulfur dioxide. When exposed to moist air, sulfur tetrafluoride fumes and creates a mist or fog of hydrofluoric acid.

Sulfur tetrafluoride is shipped in steel cylinders as a liquefied gas (B.P. —38° to —37° C.) under its own vapor pressure of 140 p.s.i.g. at 70° F.

Sulfur tetrafluoride as presently supplied, has a purity of 90 - 94% and contains 5 - 9% thionyl fluoride and 0.3% maximum chlorine.

Sulfur tetrafluoride reacts with a wide variety of compounds forming selectively fluorinated products, e.g., it replaces carbonyl oxygen with fluorine; it converts a carboxylic acid group (or carboxylic acid ester, chloride, anhydride, or amide) to a trifluoromethyl group without generally affecting olefinic and acetylenic bonds and other functional groups like fluoro, chloro, bromo, nitro, etc. Thus the preparation of a diverse number of fluorinated products heretofore unavailable by practical routes, is now possible.

Recommended Controls:

Automatic Regulator	Matheson No. 15-330
Manual Control	Matheson No. 55-330
Lecture Bottle	Matheson No. 33

Vinyl Fluoride

Vinyl fluoride is a low-boiling monomer produced from acetylene and hydrogen fluoride in the presence of a catalyst. It is a flammable gas but it is comparatively non-toxic.

At room temperature and atmospheric pressure, vinyl fluoride is a colorless gas with a faint ethereal odor. It is shipped in steel cylinders as a liquefied gas (B.P. —97.5° F.) under its own vapor pressure of 355 p.s.i.g. at 70° F. As presently supplied, vinyl fluoride has a minimum purity of 99.9% and contains 0.2% of an inhibitor (Terpene B). Inhibited vinyl fluoride has excellent storage stability.

Vinyl fluoride is of interest as a chemical intermediate since it undergoes typical olefin reactions. Vinyl fluoride undergoes polymerization to form a homopolymer, and it can also be copolymerized with other monomers.

Recommended Controls:

Automatic Regulator	Matheson No. 12-320
Manual Control	Matheson No. 51-320
Lecture Bottle	Matheson No. 32, No. 59



Fig. 1

Allene

Allene (supplied with a minimum purity of 99%) is a colorless, flammable, comparatively non-toxic gas at room temperature and atmospheric pressure. It is shipped in steel cylinders as a liquefied gas (B.P. —30.1° F.) under its own vapor pressure of 102 p.s.i.g. at 70° F.

Allene is of interest in organic synthesis. It is isomerized to methyl acetylene on treatment with metallic sodium or sodamide. In the presence of sulfuric acid, allene may be hydrated to acetone. Allene reacts with alcoholic potassium hydroxide to give ethyl isopropenyl ether. Allene reacts with hydrogen cyanide to form both beta methylacrylonitrile and crotononitrile. Bromine (2 moles) adds to allene to give 1,2,2,3-tetrabromopropane. Hypochlorous acid reacts with allene to give 1,3-dichloroacetone and 2-chloro-2-propen-1-ol, which can react further to form 1-chloro-3-hydroxy-2-propanone.

The above reactions of allene are illustrative of the scope of its reactivity.

Recommended Controls:

Automatic Regulator	Matheson No. 17-510 (see Fig. 1); No. 70-510
Manual Control	Matheson No. 50-510
Lecture Bottle	No. 31, No. 58

We suggest you contact our Sales Engineering Department if any additional technical information is required.

A supplement to Matheson's Compressed Gas Catalog has been prepared to give prices and purchasing information on all three of these gases. Please check the coupon below. Also available, our Compressed Gas Catalog, Cylinder Valve Outlet Bulletin and our Wall Chart on "Safe Handling of Compressed Gases".

The Matheson Company, Inc., P.O. Box 85-B E. Rutherford, N.J.
Please send the following:

☐ Sulfur Tetrafluoride, Vinyl Fluoride, Allene Bulletin
☐ New Matheson Gas Catalog ☐ Cylinder Valve Outlet Bulletin
☐ Wall Chart: "Safe Handling of Compressed Gases"

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Dependability
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fabrication

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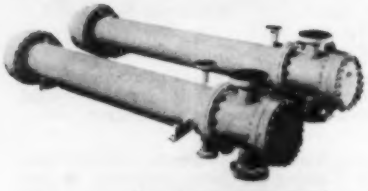


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Send for Bulletin No. 1159—"SC" Series

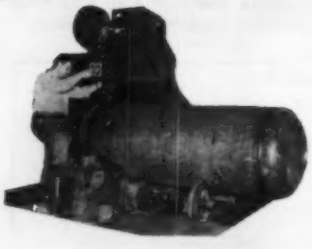
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For more information, turn to Data Service card, circle No. 136

letters to the editor

Lend a helping hand

To the Editor:

At a recent meeting of the local section of the A.I.Ch.E. at Columbus, Ohio, one of the speakers reviewed the activities of the Committee which is engaged in locating obsolete but still serviceable equipment and making it available for use in school laboratories. This program is certainly of interest to us, and I would appreciate it if you could tell me what steps we should take to become beneficiaries of such service.

We have a small but very active and growing Chemical Engineering Department, and we are expanding our facilities as rapidly as possible. Due to a somewhat limited floor space, we can make effective use of only small equipment at this time. Centrifuges of the basket or cylindrical bowl type, in small sizes, would be welcome. We would also be happy to receive any control instruments for control of temperature, pressure, fluid flow, etc., or any recording instruments.

My principal interest in the work of this committee, however, is in the possibility of their extending their activities to include library material. We have recently succeeded in supplementing our file of *Chemical Abstracts* so that we have a complete set of bound volumes from 1924 to the present date. We have bound volumes of *Industrial Arts Index* from about 1950 to present date. We are in need of back issues of nearly all of the technical and trade journals. We would like particularly to get back issues of publications of all the professional engineering societies, the publications of the American Chemical Society, *Chemical Engineering, Petroleum Refiner*, and *Petroleum Engineering*. We would of course appreciate bound volumes, but unbound copies would be most welcome.

During the years my personal collection of back issues had an unhappy way of accumulating in the attic until I found myself nervously estimating the probably allowable load limit on the attic floor. Usually about this time my wife would inform me that she had again spent a day in "rearranging the dirt" in the attic and I would know that the time had come to clean

continued on page 28

NEW... from K&M

EXTERNAL PILOT-OPERATED PRESSURE REGULATOR

fast-acting, accurate . . . tight shut-off even on dead-end service

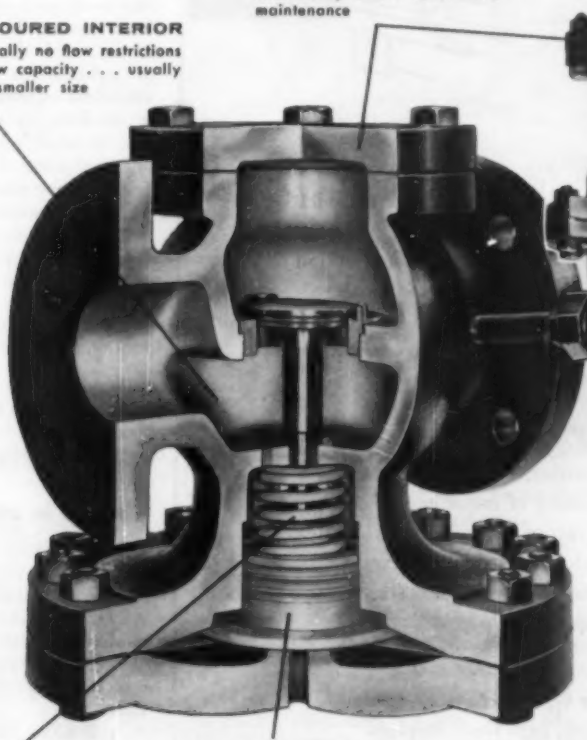
Examine it yourself . . . feature for feature. K&M has made a vast improvement in external pilot-operated pressure regulators.

It simplifies installations: *requires one less pipe line.* It offers lowest maintenance: *the result of good hydraulic and mechanical design throughout.* It gives excellent performance: *try one and compare with any other regulator of its type.*

BUILT-IN STRAINER
protects pilot from scale, dirt, other foreign matter, is removable for cleaning

BLIND FLANGES
on both main valve and pilot allow easy access for routine maintenance

CLEANLY CONTOURED INTERIOR
has no spider, practically no flow restrictions . . . gives greater flow capacity . . . usually permits economy of smaller size



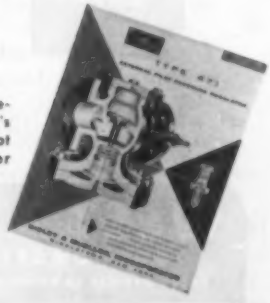
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permits convenient external pressure setting

GUIDE PISTON
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is isolated from main flow stream for greatest protection

If you would like a more detailed, close-up look at K & M's new Type 471 External Pilot Pressure Regulator, send for Bulletin 471A.





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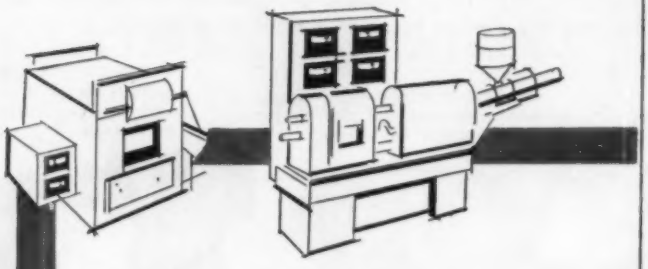
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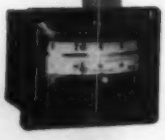


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"Our equipment sells best on performance, including ease of operation and maintenance. We can't risk dissatisfaction that stems from components, such as instruments. We're safer with Gardsman, by West, and their world-wide service."

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"Instrumentation can be the key to overall efficiency of major equipment. West temperature controllers work better than most, definitely save on several counts . . . including initial cost. It pays to specify."



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For more information, turn to Data Service card, circle No. 38

letters to the editor

from page 26

house. Out would go my "library." I have just recently donated my file of *Transactions of A.I.Ch.E.* and *Chemical Engineering Progress* dating back to 1946, along with some other publications, to our library here at West Virginia Institute of Technology. When we moved to West Virginia last fall, I found myself in a house without either attic or basement, and we just had to have some room for people.

Perhaps among your readers there will be some like myself who would like to dispose of an accumulation of back issues. It is also possible that in view of the increasing quantity of publications each year, and the attendant expense of keeping a library up to date, some companies may decide to abolish their private libraries, and make use of public library facilities in cases where such public libraries are conveniently located. We would welcome all contributions, and I can assure you that the material received will be put to good use.

RALPH H. WING
West Va. Inst. of Tech.
Montgomery, W. Va.

Readers with back issues in attics, and companies and equipment manufacturers with surplus items, are urged to write directly to Ralph Wing—ED.

A mixup in affiliations

To the Editor:

We were very much disturbed at the biographical data on Messieurs A. D. Fell and H. A. Thornton included with publication of their article "High Temperature Canned Pumps" which appeared in your July 1960 issue.

A B.S. in Ch. E. is attributed to Mr. Fell, whereas we indicated in the biographical sketch supplied to you that his degree is in Mechanical Engineering.

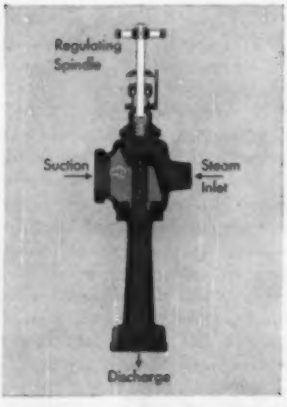
No degree at all is indicated for Mr. Thornton, nor is mention made that he is a member of A.I.Ch.E. Mr. Thornton holds a B.S. in Chemical Engineering, Drexel Institute of Technology. We strongly feel that this, as well as his A.I.Ch.E. membership, should definitely have been included in the biographical information. Unfortunately, though galleys of the article itself were submitted to us, we were not given opportunity to proof the biographical data. We feel that this should have been done as it

continued on page 30

ON THE WAY... SAME DAY



The ejector illustrated in photo and drawing is one variety of SK Steam Jet Exhauster—an air and gas pump which operates on the jet principle using plant steam. As indicated, these units are standard, general-purpose units economically suitable for applications such as pump priming, exhausting, evacuating, cleaning, transporting, compressing, agitating, and general vacuum service. Jet Exhausters are made and stocked in cast iron, stainless steel, Haveg, hard lead, PYREX brand tubing, and impervious graphite in popular sizes, see Data Sheet J-2. They can also be made in bronze, Monel, Everdur, and other machinable materials. In addition to these units, SK also makes a complete line of Steam Jet Vacuum Pumps for providing a range of suction pressures from atmosphere to 25 microns Hg abs. Refer to Bulletins 5E, 5H2, and 5H3 for information on these.



This jet ejector is being shipped from SK stock on the same day the order arrived.

This is *one* of *three* vital reasons why it pays to buy jet apparatus from SK. The others . . .

. . . one, SK pioneered the jet ejector in 1876 and, since then, has accumulated a wealth of valuable data on jet ejector application and performance. Everything we've learned is available to customers.

. . . two, SK has "special material" jet ejector designs unequalled by any other manufacturer. Many are carried in stock. Thus, customers can choose the best material for the job.

Recently, SK published a data sheet on ejector types, special stock materials, and sizes stocked. It's a valuable addition to any engineer's "source file." Get a copy merely by requesting "Data Sheet J-2."



For immediate delivery, standard SK Jet Ejectors, Rotameters, and Flow Indicators are stocked in Cornwells Heights (Phila.), Pa., Houston, Texas, and San Francisco, Calif.

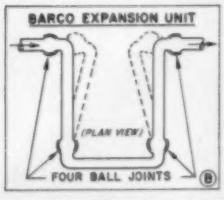
JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
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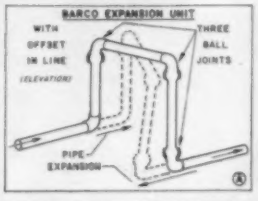
For more information, turn to Data Service card, Circle No. 76

Handling Pipe Expansion in 1,300 ft. Asphalt Lines

PROBLEM—At this plant in Arkansas, asphalt at 500°F is pumped from refinery through approximately 1,300 feet of steam traced 6" insulated steel pipe. Heating of the piping causes a considerable increase in length. The problem of calculating movement and making proper allowance for this pipe expansion was complicated by the fact that the piping runs at various angles and elevations. *(See ANSWER below.)*



These schematic diagrams from Barco Bulletin 31A explain the accompanying photos.



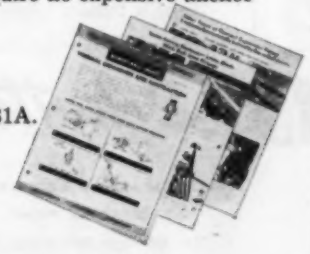


BALL JOINT EXPANSION UNITS

(NO REACTIVE FORCES)

ANSWER—Barco Ball Joints solved the "pipe expansion" problem SIMPLY, ECONOMICALLY, EFFECTIVELY. No complicated calculation of stresses was required—Barco Ball Joints (see arrows) provide *points of flexibility*. In offsets (A), three joints allow for expansion; or four joints (B) are used to form a minimum size expansion loop.

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BARCO MANUFACTURING CO.

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For more information, turn to Data Service card, circle No. 8

letters to the editor

from page 28

would have avoided this slight to Mr. Thornton.

GEORGE DASHNAU
Marketing Division
Fostoria Corp.

No slight intended. Type was set including Thornton's B.S.Ch.E., but at the last minute was whittled down to make the copy fit the space. Calling Fell a chemical engineer was a goof, but immodestly it might also be called a compliment—ED.

Local section news: How-to-do-it

To the Editor:

I am the Public Relations Chairman of the Southern California Section of the A.I.Ch.E. One of the duties of this committee is to submit local section news items for publication in CEP. Since my information is third or fourth hand, I would appreciate your answers to the following questions:

1. How much detail do you desire on monthly section meetings?
2. Are you interested in other local section news, and if so, what type?
3. What sort of format do you wish submitted items to have—i. e., triple spaced, 1½ inch margins, 8½" x 11" pictures?
4. To whom in your organization should these be addressed?

PAUL L. ARMSTRONG

This is a query which comes up frequently. To help other hardworking P.R. committeemen, we're printing the four-part answer sent to Reader Armstrong.—ED.

1. In general, a 200-word or so work-report with pertinent comments made at the monthly section meeting is sufficient. Occasionally, a speaker will have an especially fine message, and in these cases we would always be happy to look at his entire text.

2. Where the Local Section has conducted a project such as a salary survey, or a talk, we would like to receive a copy of such reports for consideration. If any Local Section member gets national prominence we would like to know about this.

3. Material should be typewritten, double spaced, and with one-inch margins. Photos are preferred having 8 x 10 dimensions and glossy finish. Where these are not available, or are quite expensive, smaller photos are acceptable if the images are sharp and clear.

4. Address news to "Local Section Editor."

For more information, circle No. 60 ➤

ANNIN VALVES

"STAGE CENTER" AT THE 15TH ANNUAL INSTRUMENT-AUTOMATION SHOW

Booth 613

(front and center on the main floor)



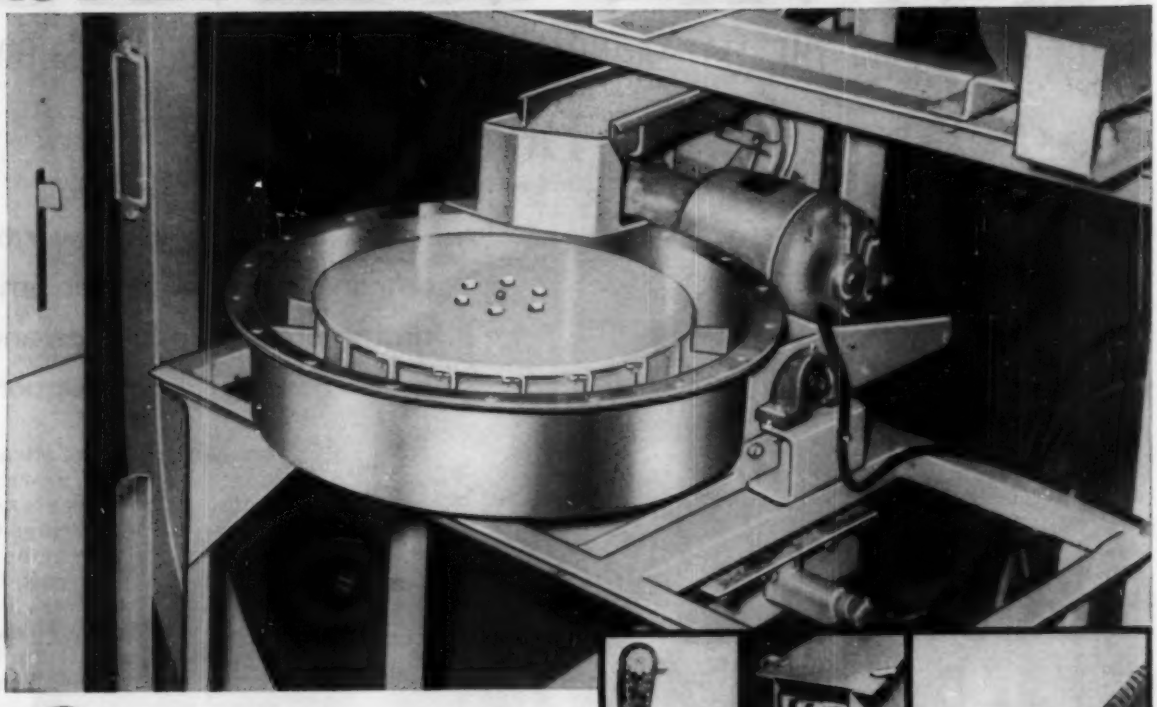
...the proven answer to complex fluid control problems in the process industries and missile ground support

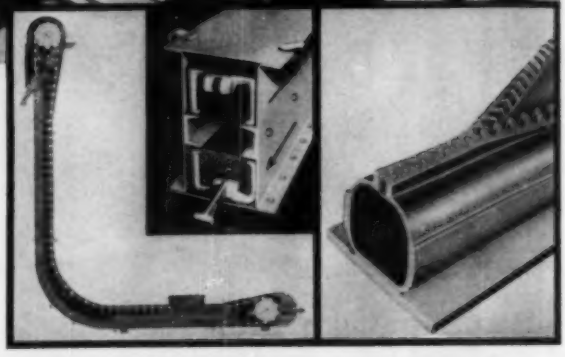
Always the center of attraction where the newest control valve concepts are sought, ANNIN brings to this year's Instrument-Automation Show new designs... new solutions... to complex control problems for industry and the military. On display—an improved standard valve line augmented by custom-built electro-hydraulic and pneumatic-hydraulic actuators. For missile and space vehicle ground support, Annin presents for the first time a self-draining valve for storable propellants, and a new vacuum jacketed valve for the control of liquid hydrogen. Check ANNIN first...and discover why no other line of valves and actuators offers so much in design and performance features.

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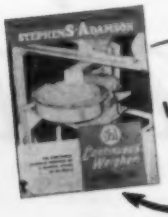
The STEPHENS-ADAMSON Continuous Weigher weighs material continuously while in motion with extreme accuracy. Material entrance and exit points are in line with pivot axis of weigher providing for easy installation within existent processing operations and completely eliminating all discharge terminal errors. The unit handles hot material with equal accuracy. Minimum headroom is required. The weigher can be adapted with control equipment for accurate gravimetric feeding without requiring extensive plant alterations. STEPHENS-ADAMSON engineers will be happy to work with you on automating your processing operations.

S-A REDLER CONVEYOR

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S-A ZIPPER CONVEYOR

Literally a moving, material-carrying conduct, the zipper closed belt, conveyor-elevator is capable of transporting bulk materials in any plane, to considerable heights and around obstructions. Bulk materials are conveyed free of breakage, agitation or segregation within the sealed and dustight belt. The zipper combined with Continuous Weigher is ideal for automatic feeding operations. Request Bulletin 349.



WRITE FOR BULLETIN 958

S-A

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For more information, turn to Data Service card, circle No. 83

Undergrad enrollment takes double-dip

ENGINEERING ENROLLMENT IS ON A CONTINUED DOWNSWING reports the U. S. Department of Health, Education, and Welfare. In a detailed analysis of last year, the Department says total engineering enrollment in Fall, 1959, was 3.9 percent lower than the previous year, which was 6.3 percent lower than that reported in 1957.

While the total decline is to be viewed with concern, even more alarming is the notation that the *undergraduate* engineering enrollment is where the big loss occurred. Undergraduates enrolled in Fall, 1959, totalled 242,992, which was 5.4 percent lower than in the Fall of 1958, and 9.6 percent lower than in the Fall of 1957. Most significantly, undergraduate enrollment decreased more from the Fall of 1958 to the Fall of 1959 than it did from the Fall of 1957 to the Fall of 1958.

Freshmen engineering enrollment of 67,704 was down 3.3 percent from Fall, 1958, and down 14.0 percent from Fall, 1957. The bright spot came from graduate enrollments which reached new peaks. Enrollment for master's degree numbered 29,713 an increase of 5.6 percent from the previous year. Doctor's degree candidates numbered 5,643, up from 18.5 percent the previous year.

Enrollee exodus

Since the early 1950's, there has been a steady increase in the dropout rate of engineering enrollees, at all levels, who do not continue on to obtain their first degree. At the freshman level, a high of 64.8 percent of the enrollees in 1950 continued on to a degree. However only 52.4 percent of its freshman class were around to collect degrees bestowed on the class of 1958. There was a surprising dropout rate among senior students. While in 1950, 99.7 percent of the senior class completed the school year and earned degrees, in 1958, only 86.0 percent of the seniors were around at commencement time. Similarly, fewer sophomores are going on to be juniors, and fewer juniors are entering the senior class.

The Department analysts could come to only one conclusion: a significant trend is in evidence. If it continues, and is coupled with the decline in freshman engineering enrollment, it is certain to result in a decline in the number of engineering degrees in future years. The enrollment trend cannot be expected to support the increased rate at which engineering degrees have been conferred in recent years. A total of 45,601 graduates at all levels received degrees in 1958-59. This has been the fifth consecutive year of increases, since 1953-54, when 27,003 degrees were granted. It is still considerably below 1949-50, when the record number of 58,130 degrees were bestowed.

How are the Chemicals doing?

Enrollment in chemical engineering at the freshman level has remained the same percentagewise, although it dipped with the decline in total enrollees. Of the freshman Engineering class of 1959, 11.4 percent were working toward a Ch.E. degree, the same as in 1958. Electricals topped the list with 29.7 percent, an increase of 0.3 percent, Mechanicals were next with 20.3 percent, down from 22.1 the previous year, and Civils were in third place with 14.6 percent, up from 13.9 in 1958.

Degrees awarded at the first level in 1958-59 came to 38,134, up from 35,332 the previous year. The Chemicals had 8.2 percent of this number, down from 8.5 percent. Again the Electricals led with 28.3 percent, up from 27.1; Mechanicals had 25.2 percent, down from 25.6; and Civils 14.1 percent, down from 14.5.

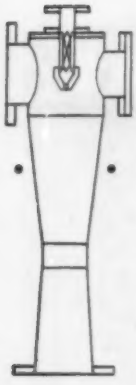
Incidental statistics compiled in the report show New York State in first place in undergrad engineering enrollments in Fall, 1959, with 20,729; Pennsylvania second with 15,743. Both states ranked the same in number of B.S. degrees given in 1958-59, with 3,236 and 2,751, respectively. The school with largest undergrad engineering enrollment was Purdue with 5,660, also leading with 1,099 B.S. degrees conferred. Its Big Ten neighbor, Illinois U., was second in both categories with 5,397 enrollment and 827 degrees.

New York had the most undergraduates enrolled in chemical engineering with a total of 2,024, and gave the most Ch.E. degrees—329. Pennsylvania was second with 1,678 Ch.E. undergraduates and gave 271 degrees. Cincinnati U. and CCNY ran one-two with Ch.E. undergrads, having 570 and 560, respectively. But Purdue and Wisconsin U. gave most Ch.E. degrees, 110 and 89 in 1958-59.

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opinion and comment

Know Your Competition

A SALESMAN'S CREDO includes the phrase "Know your competition . . ." In so knowing he knows the best way to meet it and to best it. In today's world the most formidable competition faced by U. S. engineers is the U. S. S. R. For despite the heavy emphasis on propaganda, Russia's chief aim, short of war, is to best us in the worldwide marketplace. It takes technical manpower to provide efficient processes, which provide economical products, which provide sales in the market. Knowing what Russia is doing in these areas is of utmost importance to the engineering community.

Fortunately, despite tension at high governmental levels, there is still quite an exchange of individuals between the two countries. Two recent delegations included A.I.Ch.E. members, and observations made by them are of considerable interest. Dave Boyd, Universal Oil Products, attended the meeting of the International Federation of Automatic Control in Moscow, and his report is carried in this issue in the Scope feature.

He was additionally afforded an opportunity to tour a refinery (with camera), and some of the photos he took are also in this issue in the Camera pages. While the photos speak for themselves, and show no significant achievements in the instrumentation field, Dave notes that Russia has definitely set automation as one of its national goals, and further use of sophisticated controls can be expected from work underway at the Leningrad development center.

EJC takes a look

Walter Lobo, meanwhile, was in an Engineers Joint Council delegation which spent a month studying the utilization of engineers and technicians. A preliminary report they made makes some interesting points:

The Soviet curriculum requires 5½ years for a degree (1½ of practical training), but excludes humanistic social courses. Foreign languages and political economy, however, are included.

Only 20 percent of high school graduates are permitted to go on into higher education. The competition to get into college and stay there is reflected in high academic standards—more than 75% of the students qualify for stipends, which are dependent on academic accomplishments.

Technical institutes turn out 250,000 industrial graduates annually for industry. The U. S. turns out only 14-16,000 annually, and the report stated not over 1,000 of ours are of the quality of those trained in the "technicums".

About 108,000 engineers are graduated each year (during 1958-59 U. S. Schools conferred 45,601 degrees at all three levels), but many are assigned to nonengineering jobs, some in the worker category.

Approximately one-third of engineering and technical institute students are women. A smaller percentage held top administrative positions, and the delegates felt the motivation to train women engineers is apparently one of "need" rather than desire for equal opportunity.

Knowing a bit more about our competition, what can we do about it? This question can require volumes for an adequate answer. The EJC group says for one thing we must become more serious in our view toward education. The Trends story this month implies another; namely industry better make engineering more attractive as a profession. For, Trends points out, engineering enrollment is not only continuing to decline, but the dropout rate among enrollees is on the rise; a compounded deficit.

L.R.

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Alfred H. McKinney
Du Pont Co.

Radiation techniques for process measurements

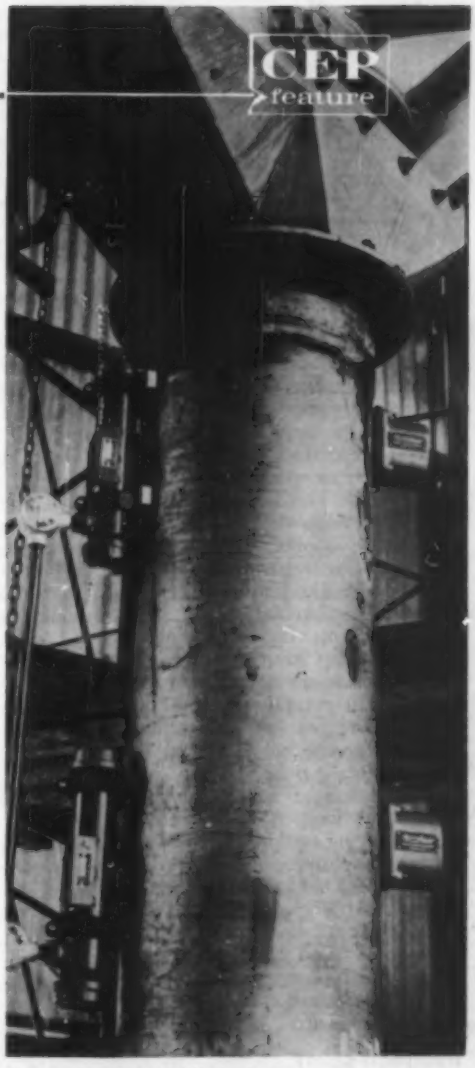


Photo courtesy Industrial Nucleonics Corp.

Penetrating radiation can give valuable information concerning process conditions that are not available by other methods. By judicious placement of the equipment, measurements such as level, density, concentration, viscosity, flow rates, etc. can be obtained.

The components for a required installation are readily available, but most installations will require source sizing and placement calculations. Included are charts, previously unpublished, for reducing differential equations and trial-and-error problems to simple algebra for various geometrical arrangements.

This article tells how to make various measurements and provides the details to solve typical problems.

Industrial applications

Obtain reliable process measurements such as liquid levels, density, and flow rates by using radiation techniques.

Gamma gaging techniques have been used to measure liquid and solid levels for a number of years and are applicable to many other process measurements. They respond to the mass of material between source and detector. The interpretation of the resulting measurements depends upon the geometry. The radiation beam should pass across or through the top surface for level measurements or through the material for density. It is also possible to arrange the source and detector around the processing equipment for measurements responding to other variables, such as thickness, viscosity, angle of repose, solids flow rate, etc.

The first gamma gage installation in a plant may be a major undertaking. Other approaches and gadgets will be tried first and a gamma gage installed only after everything else fails. This is one feature of a radiation measurement—it can work when nothing else will. It can be located external to the process equipment and may not require a shutdown to be installed. It adds no restriction to, draws no power from, and is not corroded by the process material it measures.

Gamma gages have proven to be highly reliable. After the first installation, others usually follow even when nonradiation types will work. Sometimes it is instructive to use both on the same measurement since differences, properly interpreted, provide illuminating process information.

Some measurements present no

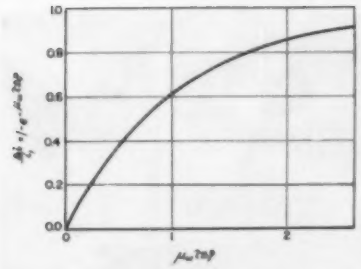


Figure 1. Variation of operating signal with change in process conditions.

Table 1. Typical radiation exposures.

SITUATION	INTENSITY	DOSE
Cancer therapy		10,000,000 + mr
Chest x-ray	5,000,000 mr/hr.	200
Dental x-ray	1,000,000	900
A.E.C. "Radiation Area" (*1*)	5-50 mr/hr.	150 mr/week*
Radium dial wrist watch-front	5	–
Gamma gage installation		
1. At surface of Source Holder	5	–
2. Radiation Detector	0.5 to 5	–
Mountain top	–	3.5 mr/week**
Sea shore	–	2.8 mr/week**

** Avg. dosage per week permitted under A.E.C. regulations.*
*** Avg. accumulative dosage per week.*

problem, an order can be placed for off-the-shelf equipment. In other instances, the required arrangement may involve considerable study to explore feasibility or to specify unusual components. The user is well advised to make or share in such studies, as the instrument supplier cannot be expected to know all of the process equipment and conditions which may affect the measurement.

Arrangements involving oblique angles or strip sources give rise to equations that are not easy to solve. Solutions to several of these problems are given as dimensionless charts which are not known to have been published before. These should be useful to the instrument manufacturer as well as to the user of gamma gaging equipment. It becomes a fairly simple procedure to estimate the required source size once the arrangement is specified. The several sections which follow describe the details which must be considered for safety reasons and to produce the necessary information for various process measurements.

Radiation safety

Gamma radiation (photons) emitted from a radioactive isotope is the common form of energy used for process measurements while in a few instances beta radiation (electrons) is more suitable. Some sources emit both gamma and beta radiations. Neither of these forms of radiation can make any other material radioactive and when the source is removed, the radiation ceases.

The units of radiation dosage are the roentgen (r) and milliroentgen (mr). The usual unit of intensity is milliroentgens per hour (mr/hr.). Table 1 suggests the total dose or the exposure rate to be expected in certain situations.

The usual limit of radiation intensity that a person could be exposed to in the vicinity of a source and measuring equipment is 5 mr/hr. Thus, the area need not be roped off or declared a "Radiation-Area".† It should be safe for a person to be around the equipment for 40 hr./week. That does not say that a person should remain in the proximity of a radiation instrument area for any longer than necessary. There is usually no reason to do so. A more typical exposure would be two hours when the measuring equipment is first installed on a process vessel, and ½ hr./week for subsequent maintenance checks. Thus, the usual radiation exposure to the person responsible for the installation and maintenance of a radiation gage will be about the same as if he remained outdoors all the time.

Sealed sources in conventional holders as supplied by the established vendors are rugged and reliable pieces of equipment. One vendor reported that a holder recovered after a fire showed that the lead had melted inside the steel housing but had not leaked out. Another safely survived an explosion that blew it 200 ft. and drove it into several feet of earth. In both instances the radioactive source materials were still safely contained within their holders.

Every six months a "wipe-test" is required for sealed sources. This consists in wiping the nearest accessible sealing joint with a moistened tissue which is subsequently tested for trace amounts of radioactive materials. With some 100 installations within Du Pont, these tests have been negative for all sources supplied as part of a complete gamma gage.

†Access to "Radiation-Areas" limited to qualified personnel (1).

Detection equipment

Precise measurements of small changes in intensity are possible using readily available counters and compensators.

Two types of detectors are commonly used for process measurements, Geiger tubes and ion chambers. The Geiger tube and its associated equipment is less expensive and will operate at low levels of radiation, but is unsatisfactory for the reliable measurement of small changes in radiation.

Ion chambers are gas filled and each gamma photon (or beta particle) which is stopped by a gas molecule may produce an ion pair (positive and negative particle) which will move towards charged plates and appear as current in the external circuit. This output current provides a measure of the intensity of radiation surrounding the ion chambers.

Ion chambers are relatively inefficient and most of the gamma photons pass through without change. The actual response of commercially available units varies roughly from 0.02 to 0.2 micro-microamperes of output current per unit of radiation intensity (mr/hr.) per cubic inch of volume of the detector. The higher responses will be associated with higher supply voltages and more complete capture of the ion pairs produced. The response of ion chambers is proportional to the radiation intensity up to

roughly 1000 mr/hr. To increase the signal strength from weak radiation fields, larger detectors or several detectors in parallel may be used.

In some applications a process change will only make a small change in the radiation intensity at the detector. The output current will be reduced from some value, i_1, when the pipe line is empty to a lower value, i_2, when the pipe line is full or the highest specific gravity to be measured is reached. The useful signal $i_1 - i_2$, or Δi, may be much smaller than i_1. Also Δi decreases as level or density increases.

To obtain a signal which increases with an increase in the process condition, an opposing electrical signal is introduced and set equal to i_1. The net output signal is then zero at zero level or lowest density and increases with the opposite polarity as the level or density increases and the output from the measuring cell falls off. This could be called zero suppression, but is actually (and perhaps erroneously) called compensation. Compensation is accomplished by either an electrical network in the amplifier or by introducing a second ion chamber of opposite polarity in the primary circuit. An ion chamber compensator may be located away from the process measurement and has a small (microcurie) source that can be adjusted to vary the output current. An ion chamber compensator is less expensive than electrical compensation of equivalent stability.

Noise

Some noise is inevitable in the measurement of currents in the micro-microampere range. At current levels below 10^{-12} amperes full scale, the amplifier noise probably dominates and renders precise measurements sluggish because the time constant of the amplifier must be increased. If the random process of radioactive decay was observed in fixed intervals of time, as with a counter, it would be found that the standard deviation of the measurement would be the square root of the measurement, Table 2. The noise can be reduced from 10% to 1% of the signal by increasing the number of counts from 100 to 10,000. This can be accomplished by increasing the radiation intensity, or the counting interval, or both.

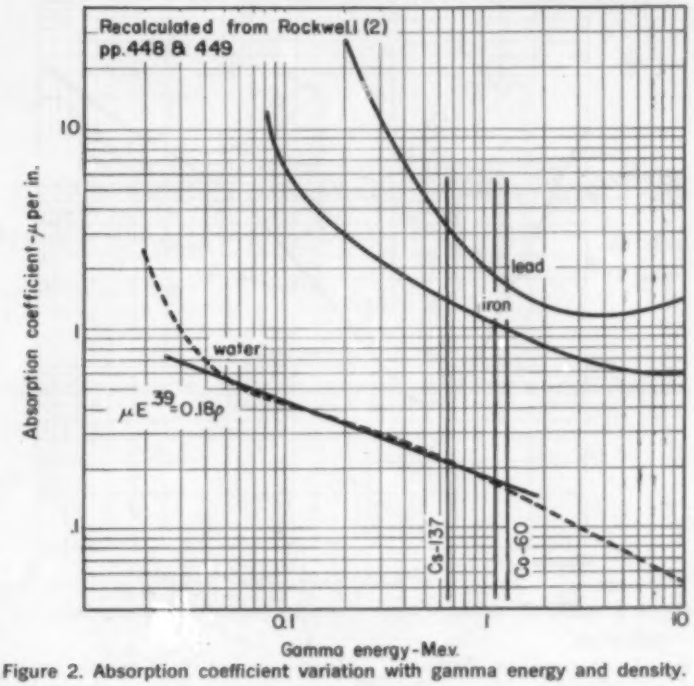


Figure 2. Absorption coefficient variation with gamma energy and density.

Table 2. Measurement deviation.

Number of counts	(Std. Error) Noise	Noise Signal
100	10	.1
1,000	32	.032
10,000	100	.01
100,000	320	.0032

With a continuous measuring system as usually employed, instead of counting over fixed intervals of time, the same general relations hold but

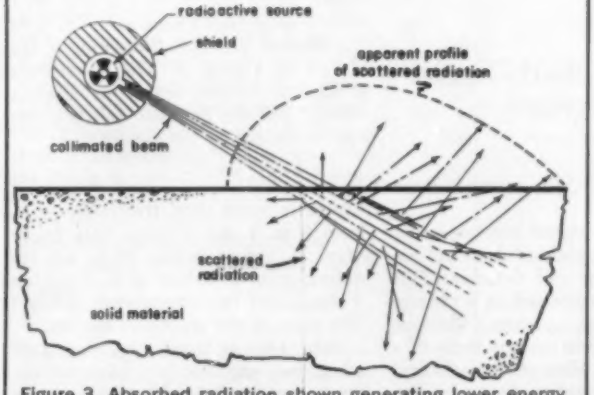


Figure 3. Absorbed radiation shown generating lower energy radiation which scatters in all directions.

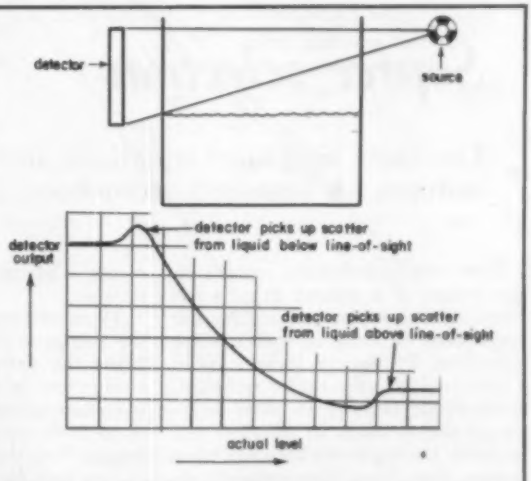


Figure 4. Detector responding to liquid level change.

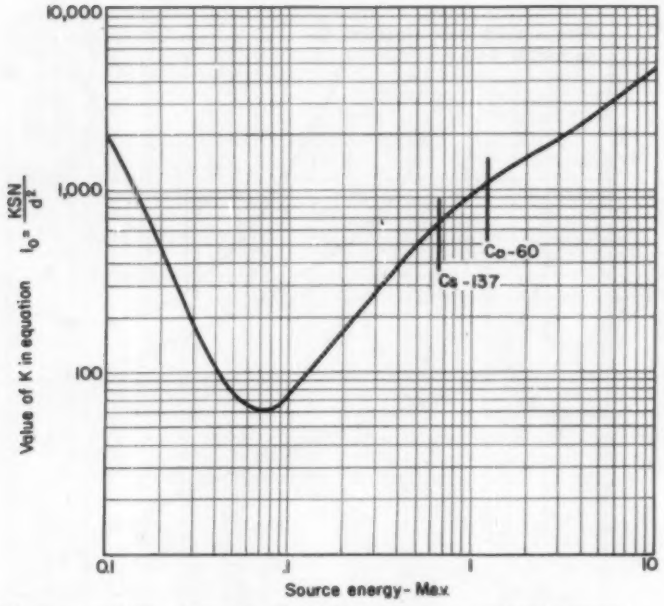


Figure 5. Radiation intensity from different gamma energy sources.

the actual values are best obtained by empirical calibration. The results of a large number of tests within a deviation of ± 2% are expressed by the following:

$$\text{Noise} = \frac{8\sqrt{i}}{\Delta i\sqrt{\theta}}\ \%\ \text{of chart} \qquad (1)$$

The constant in Equation 1 applies only to equipment from a single supplier and should be determined for other equipment. The time constant Θ is in seconds and refers to the time for the response of the instrument to measure the usual 63% of a step change of radiation intensity.

The actual noise data used to derive Equation 1 were based on arbitrary impressions of chart records running at speeds around one inch per hour. The extreme excursions of the pen show up unduly, tending to obscure the fact that most of the ink is closer to the average. Data taken at fixed time intervals give standard deviations approximately 1/6 of the noise figures as usually reported and as predicted by Equation 1.

In comparing x-ray and radioisotope emissions, x-rays are much more constant second-by-second but likely to show changes in day-to-day operation requiring frequent calibration. A gamma gage using an isotope having a half life of five years or more should not drift more than 2% per month.

Source selection

Use these simplified equations and charts to size isotopes for standard geometrical designs.

The next consideration arising in the design of a gamma gage is the selection of a source suitable for the application. In many cases this is not a problem. To measure liquid level in a tank two feet in diameter or larger, a cobalt-60, radium, or other high-energy source would be adequate and probably less expensive than any other source. For level measurements in small columns, or density measurements, a less energetic source is more suitable.

The operating signal is obtained by the change in pounds of material between the source and detector. This change can be expressed as a change in specific gravity, $\Delta\rho$, over a distance through the process measurement of τ inches. With the absorption coefficient μ_w per inch for water, the useful signal becomes

$$\frac{\Delta i}{i_1} = \frac{\text{Useful signal}}{\text{Total signal}} = 1 - e^{-\mu_w \tau \rho} \qquad (2)$$

as a first approximation. In liquid level measurements, $\Delta\rho$ is the fluid density. For interface measurements, $\Delta\rho$ is the density of the lower phase minus the density of the upper phase. In density measurements, $\Delta\rho$ is the desired span of the final reading.

When used as a thickness gage, ρ is constant and the variable becomes $\Delta\tau$. The useful signal is then given by the following:

$$\frac{\Delta i}{i_1} = \frac{\text{Useful signal}}{\text{Total signal}} = 1 - e^{-\mu_w \rho \Delta\tau} \qquad (3)$$

Actual numbers satisfying Equations 2 and 3 are given in Table 3 and plotted in Figure 1. The typical exponential curve results for the change in radiation signal with a change in process conditions. Over the range from 0.0 to 0.2 the instrument readings will give a linear response to process changes, but the linearity of the response becomes progressively poorer as the product $\mu_w \tau \Delta\rho$ increases. However, the cost goes up as reliable operation at low signal changes is required. A signal level of 0.02 is about the limit of presently available instruments and requires stable, noise free equipment.

Table 3. Operating signal data.

Process conditions $\mu_w\tau\Delta\rho$ or $\mu_w\rho\Delta\tau$	Change in signal $\frac{\Delta i}{i_1}$	Typical application	Linearity
.01	0.010	....	....
.05	0.049	Density	Good
.10	0.095	....	Fair
.50	0.393	Level	Poor
1.00	0.632	Level	Poor
2	0.86	"	"
5	0.99	"	"
∞	1.00	"	"

If an application requires certain values of ρ and τ, one is still free within some limits to select μ to give the desired product. Values of μ are shown in Figure 2. The absorption coefficient varies with the gamma energy and the material, but is given approximately by the equation

$$\mu = 0.18\rho E^{-0.89} \qquad (4)$$

which is good over the range of ρ from 0 to 4 and E from 0.04 to 10 Mev. If higher values of μ are required at lower values of E, Equation 4 should not be extrapolated. Table 4 lists some of the available sources.

Beta rays generate gamma rays when they are absorbed (Bremsstrahlung effect) and can be used to create low energy gamma radiation. As a

rough approximation, Table 5 suggests Bremsstrahlung sources which could be considered if lower energy radiation is needed to give more absorption in a given distance. These are calculated values only. Actual measurements may differ substantially.

The cost of the source may be trivial in many instances with the handling and holder charges represting the bulk of the total cost. The most economical installation does not always work out to use the lowest source size and highest source energy. To give a specified signal, much more Cs-137 will be required than Co-60, but the amount of lead required to shield this larger amount of Cs-137 will be less. The total cost for even a large installation may be less when using lower energy sources.

Scattering

Some of the gamma photons stopped by an absorber give rise to lower energy (scattered) radiation going in all directions. This is illustrated in Figure 3. If a collimated beam enters perpendicular to a large absorber, most of the scattered radiation is also absorbed. But a large amount of scattered radiation can escape if the entering beam is oblique.

Figure 4 shows another aspect of scattering. With source and detector as indicated, the rising liquid scatters radiation to the detector before it reaches the line-of-sight cutoff position. This gives a less-than-empty level indication. Similarly, scatter causes the level to read highest when the line-of-sight is just covered.

Source sizing

There are three equations to be solved to determine the size of a source for a given application. The first equation is

$$I_0 = \frac{KSN}{d^2} \qquad (5)$$

The intensity of radiation from an unshielded point source of S millicuries at a distance of d inches is I_0 mr./hr. K is a conversion factor varying with the energy of the radiation E as shown in Figure 5. N is the number of gamma photons emitted per disintegration of the source material as indicated in Table 4.

$$I_1 = B_f e^{-X} I_0 \qquad (6)$$

gives the radiation intensity for the empty vessel or lowest density liquid where

$$X = \mu_1 \tau_1 + \mu_2 \tau_2 + \mu_3 \tau_3 + \cdots \qquad (7)$$

X accounts for all of the various materials having absorption coefficients μ_1, μ_2, μ_3, etc. and respective thicknesses τ_1, τ_2, τ_3 such as walls, jackets,

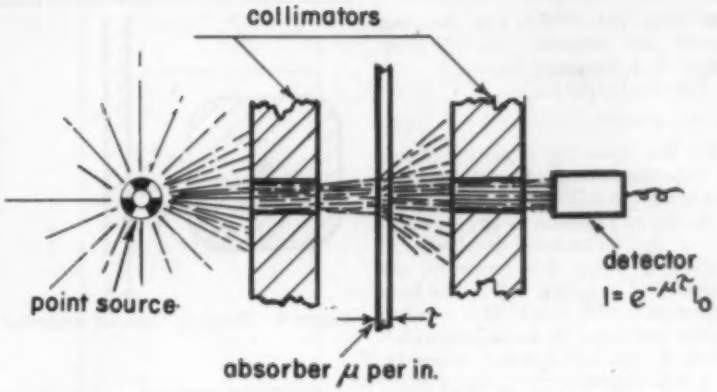


Figure 6. "Good geometry" with collimators eliminating scattering ($B_f=1$).

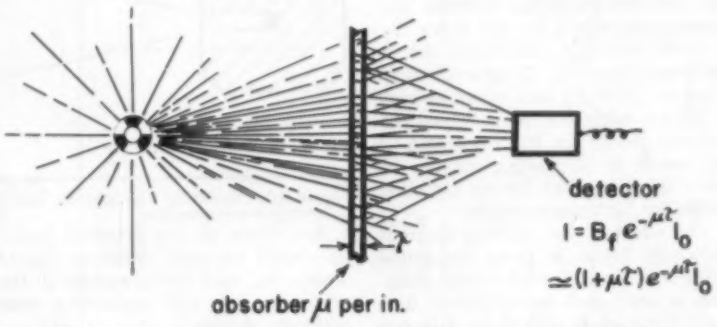


Figure 7. Example showing "build-up" effect with un-collimated radiation.

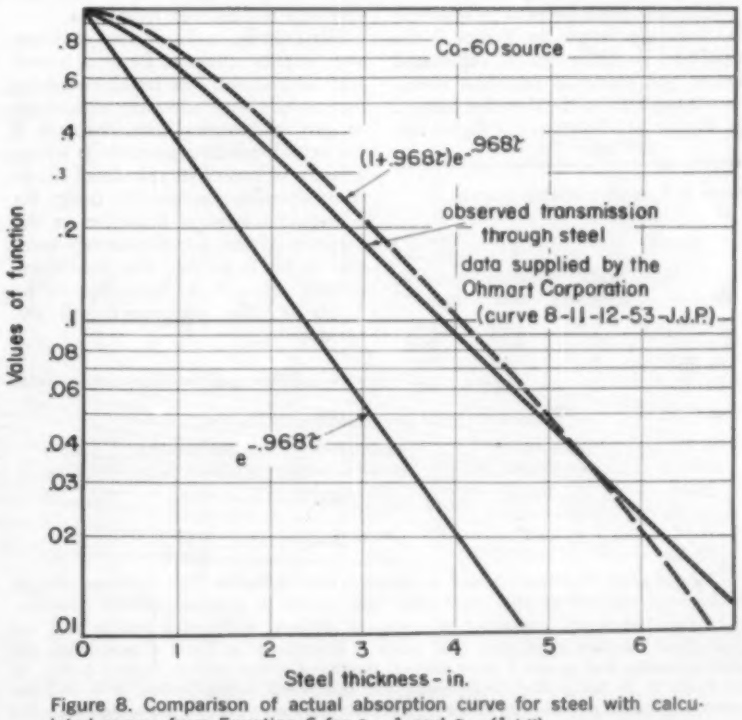


Figure 8. Comparison of actual absorption curve for steel with calculated curves from Equation 6 for $B_f=1$ and $B_f=(1+X)$.

insulation, etc., which exist between source and detector. The build-up factor B_f is discussed below.

The third equation,

$$I_2 = I_1 e^{-\mu\omega\tau\Delta\rho} \qquad (8)$$

gives the operating signal or change in radiation intensity from I_1 to I_2 for the process condition being measured.

Scattered radiation is largely eliminated by collimators as shown in Figure 6. Using this geometry, the intensity of radiation will follow from Equation 6 with $B_f=1$. This is called "good geometry" by some authors because B_f can be neglected. However, it is not realistic.

Figure 7 shows what happens when the blocks with the collimating holes are removed. Now the scattered radiation will also reach the detector and increase the signal by the factor B_f. In many practical installations this is far from trivial. B_f is approximately equal to $(1 + X)$ and values as high as 10 are fairly common. Where the build-up factor is 10, neglecting it will result in calculating sources 10 times too large and having radiation intensities 10 times too high.

The effect of the build-up factor is shown in Figure 8. Here, the actual curve for absorption of Co-60 radiation is compared to calculated data from Equation 6 with $B_f = 1$ in one case and $B_f = (1 + X)$ in the other. The latter is a more accurate expression of the actual absoption.

Judgment must be used in selecting the build-up factor. In Figure 9 the absorber is close to a collimated source and scattered radiation would contribute little to the detector output. In Figure 10, however, with the absorber closer to the detector, build-up should be used. Build-up should always be used for absorbers if the source is not well collimated with adequate shields.

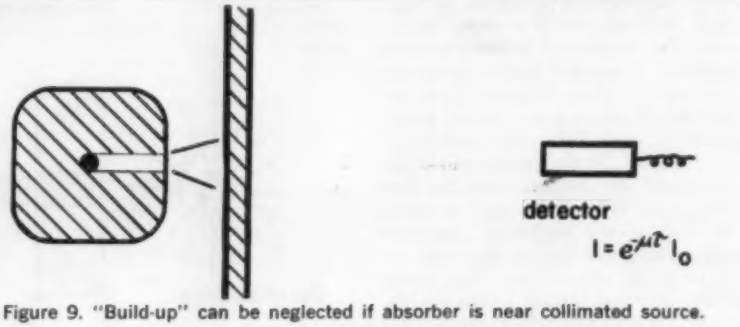


Figure 9. "Build-up" can be neglected if absorber is near collimated source.

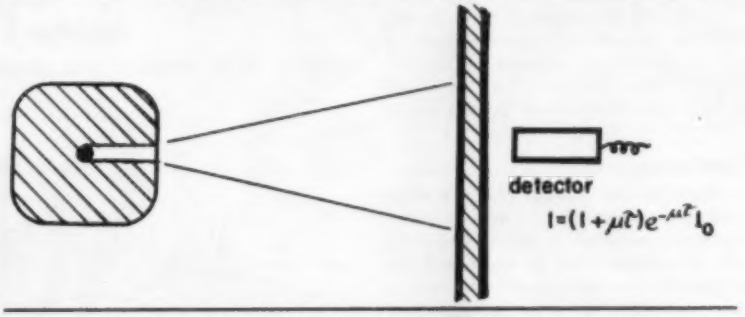


Figure 10. "Build-up" should be included with absorber close to detector.

Some allowance may also be appropriate for posts, walls, etc., not directly in the line-of-sight, but which can give rise to scattered radiations.

Fortunately, a low order of precision is quite adequate for most source size calculations. The usual measuring instruments have adequate adjustment to give satisfactory measurements if the actual radiation intensity is within a factor of two of its calculated value. A comfortable practice is to design for a radiation level of 3 mr/hr. at the detector. If the actual intensity turns out to be 5 mr/hr., the installation is still safe. If it turns out to be 1 mr/hr., the equipment will still operate.

Table 4. Typical available sources.

SOURCE	HALF LIFE, YR.	ENERGY, MEV.	N (PHOTONS PER DISINTEGRATION)**
Co-60	5.3	1.25	2.0
Cs-137	30	0.67	0.92
Ba-133	7	.33	1.0
Fe-55	3	.006	1.0

Table 5. Typical Bremsstrahlung sources.

ISOTOPE	LEAD PLATE THICKNESS*, IN.	RESULTING ENERGY, MEV.	N (PHOTONS PER BETA PARTICLE)**	HALF LIFE, YR.
Sr-90	0.025	0.7 Mev.	0.20	28
Kr-85	0.005	0.2	0.07	10
C-14	0.001	0.05	0.02	5000
Pb-210	0.0001	0.01	0.002	22

** Lead plate thickness selected to absorb ½ beta radiation. This thickness thought to be most efficient as film cover over beta source to generate gamma radiation.*

*** Equal strengths, measured in curies, of different radioactive sources may not give equal numbers of photons. The factor N is included in Table 4 to equalize this nonuniformity and permit a more general treatment of the data in Figures 5 and 12. In Table 5, N has a slightly different, but equivalent, interpretation. It is still the gamma photons per disintegration of the beta source calculated from Equation 5-1 as given by Stephenson on p. 173 of reference 3.*

Source Holders

Source holders are of two types. One type is shown in Figure 11 for external mounting. Some form of handle is provided to open the holder, permitting radiation to escape more or less collimated. Designs differ as to the degree of collimation. In the closed position the holders should be safe at all angles and suitable for shipping. Figure 12 shows the amount of lead shielding required to reduce the surface intensity to 5 mr/hr. for various source sizes and energies. It appears surprising at first glance to find that a source holder of a given size will shield a larger source of either 10 Mev or 1 Mev energy than it will if the energy is 4 Mev. Better shielding of the less penetrating 1 Mev than 4 Mev energy by a given shield is to be expected. Similarly, a larger fraction of 4 Mev energy than 10 Mev energy is absorbed. The difference is that many more photons/sq. cm./sec. are required to give an intensity of 1 mr/hr. at 10 Mev than 4 Mev or 1 Mev. This is shown by Stephenson (3) as Figure 5-1.

An unprotected source is sometimes required for mounting inside process equipment as shown in Figure 13. When the source is in place, no external shielding should be necessary. If the source must be removed, a storage box, also suitable as a shipping container, can be kept nearby. The source should be on a sufficiently long rod to avoid appreciable exposure during this transfer.

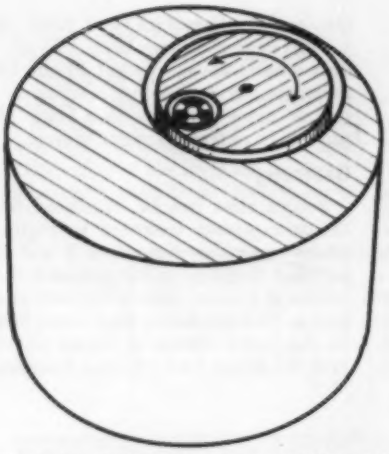


Figure 11. Typical rotary source holder. Rotation of 180 degrees will turn source to a completely shielded position.

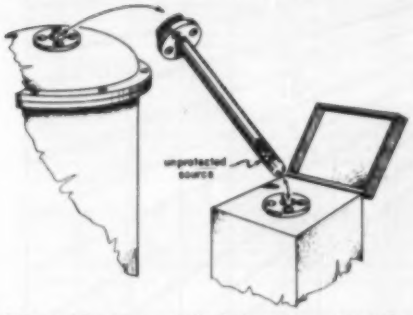


Figure 13. An unprotected source used for mounting inside process equipment.

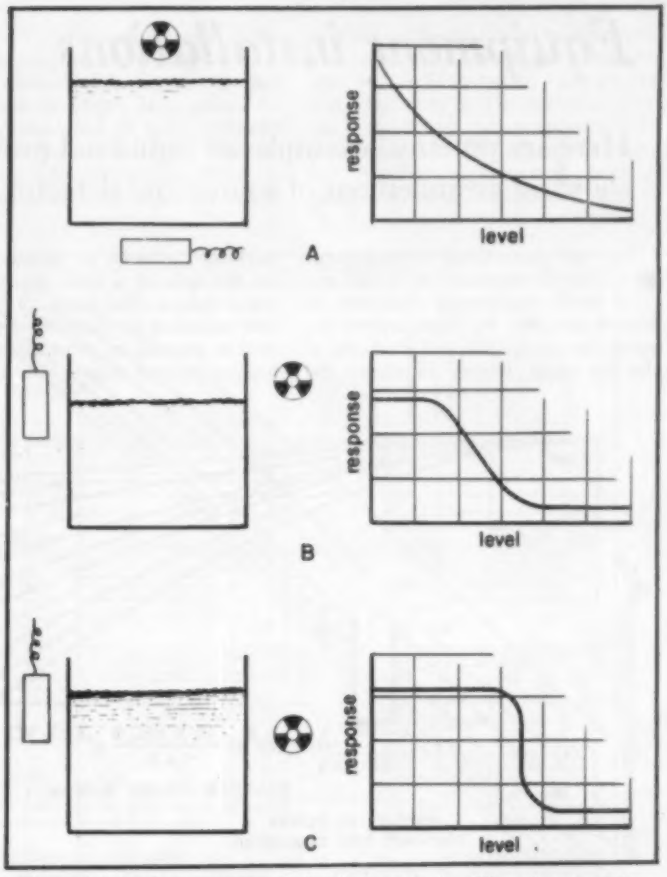


Figure 14. Typical response to level changes by different geometries.

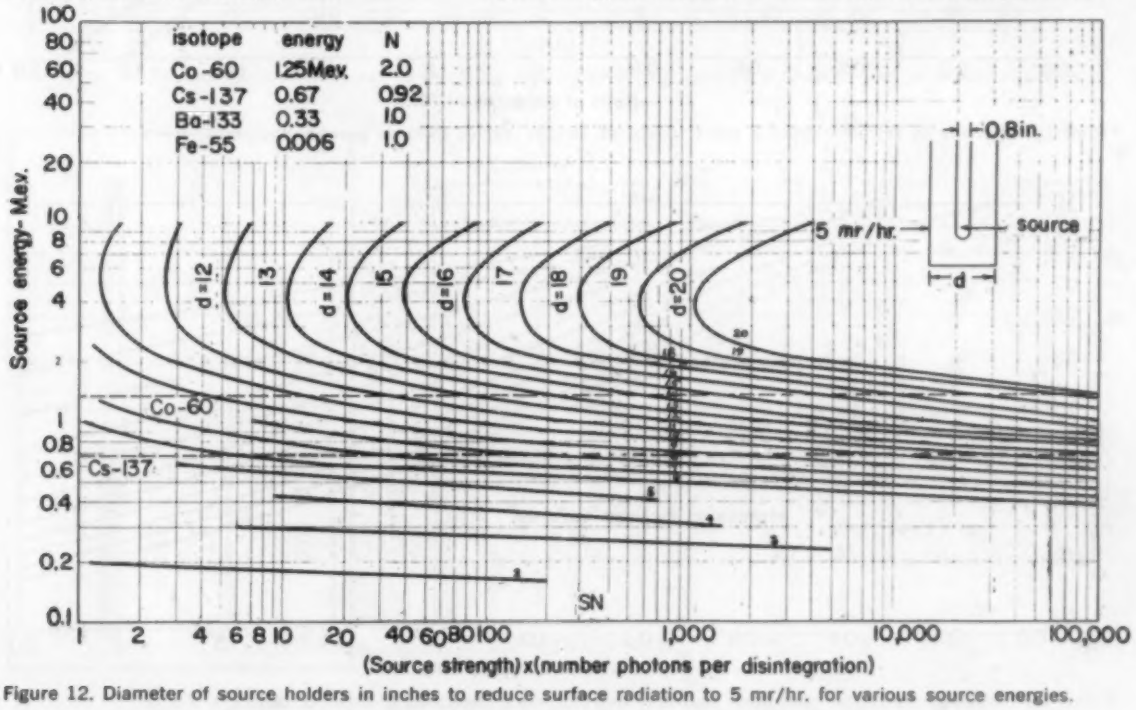


Figure 12. Diameter of source holders in inches to reduce surface radiation to 5 mr/hr. for various source energies.

Equipment installations

Here are practical examples of industrial problems showing arrangement of source and detector.

Various geometrical arrangements give different responses to liquid and solid level changes as indicated in Figure 14. The response curves depend also on the size and thickness of the container. Figure 15 shows the radiation intensity at various heights on the side of a tank opposite to a point source. The intensity of radiation indicates the instrument response at that position in percent scale reading per percent change in actual level. Obviously, either thick wall tanks or a large degree of angularity will produce a nonlinear calibration. Figure 16 indicates the cumulative reading for one or more detectors in a stack H units high opposite a point source.

Geometry

Source sizes can be calculated for the arrangement indicated in Figure 16 in two steps. Equations 5 and 6 are used to calculate the radiation intensity at a point directly opposite the source. This number is then multiplied by the factor shown in Figure 16 to give the actual total effective intensity

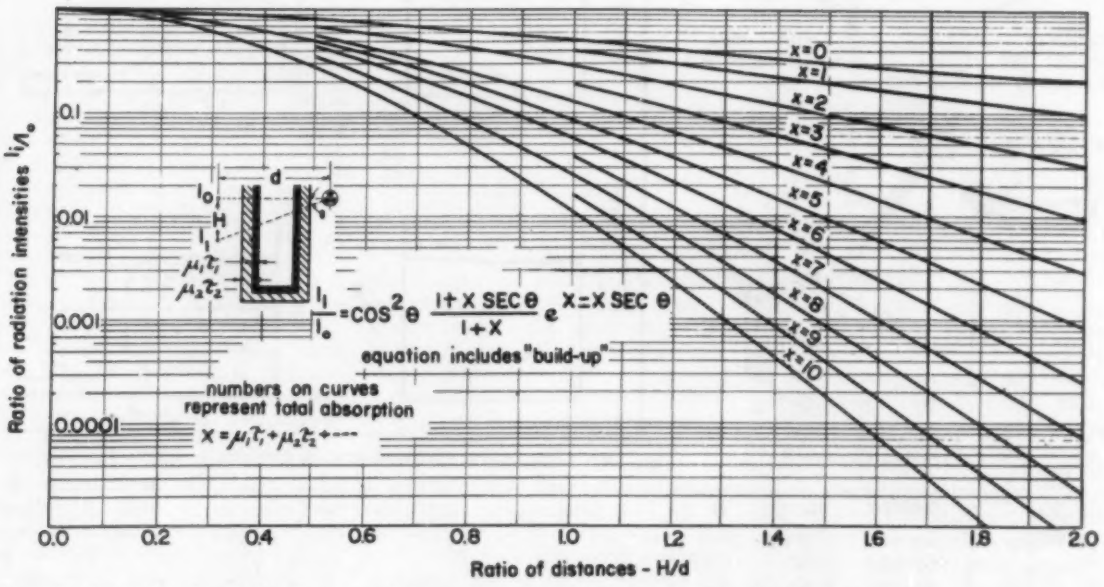


Figure 15. Intensity of radiation from a point source at oblique angles through parallel absorbers.

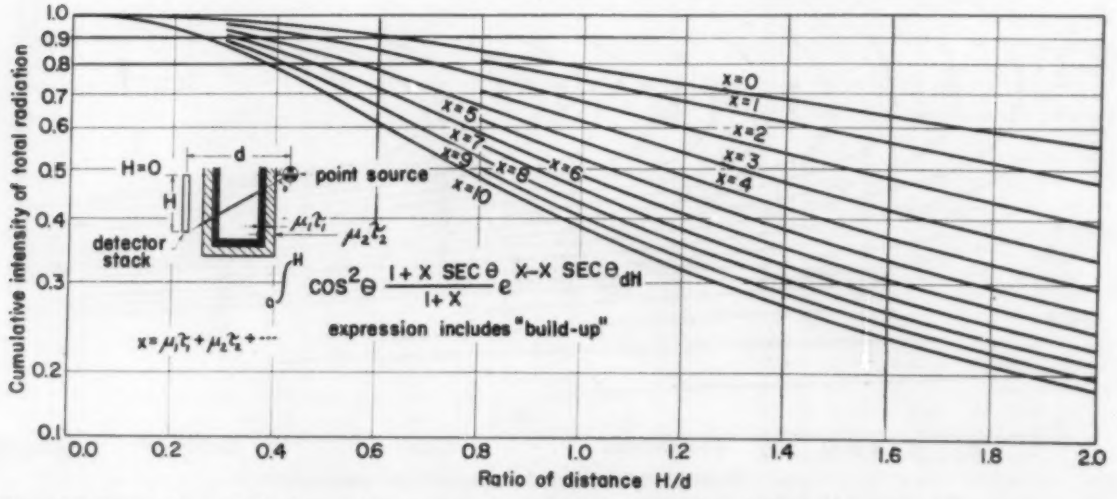


Figure 16. Cumulative radiation from point source to detector stack compared to detector of length $H = 0$.

for a specific arrangement. The build-up factor $(1 + X)$ has been included in Figures 15 and 16.

Using a point source arrangement as previously described, the measurement becomes progressively nonlinear as the range of the level measurement increases. A more linear level measurement can be obtained by one of the four following arrangements.

Strip source method. A continuous strip source of length H is placed directly opposite one or more detectors stacked to the same length. This arrangement will give a fairly linear response to level if the the strip source is close to the tank wall or immersed in the liquid. The required source strength is calculated as before using Equations 5 to 8. The radiation present in the strip source is assumed to be concentrated at a point and the radiation intensity opposite this point is calculated using Equations 5 and 6.

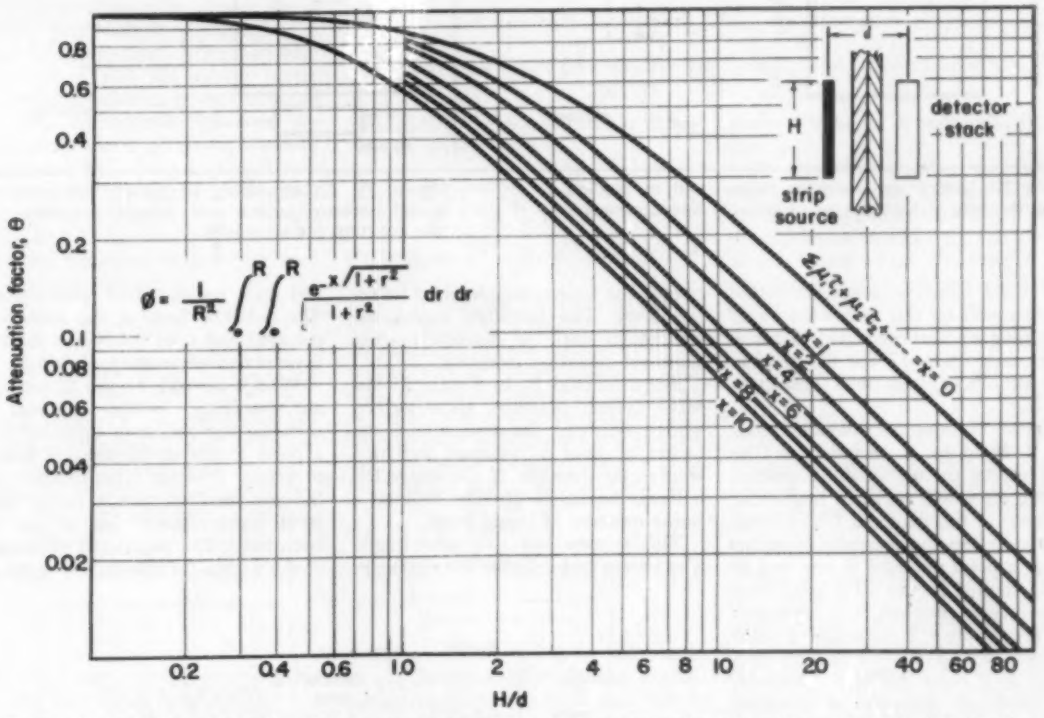


Figure 17. Radiation attenuation due to geometry parallel to strip source for H/d ratios and wall absorbancies.

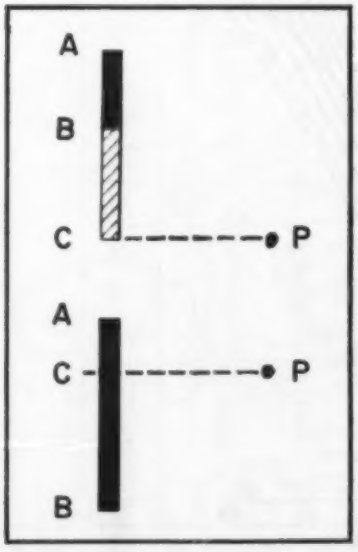


Figure 18. Intensity at random position with respect to strip source.

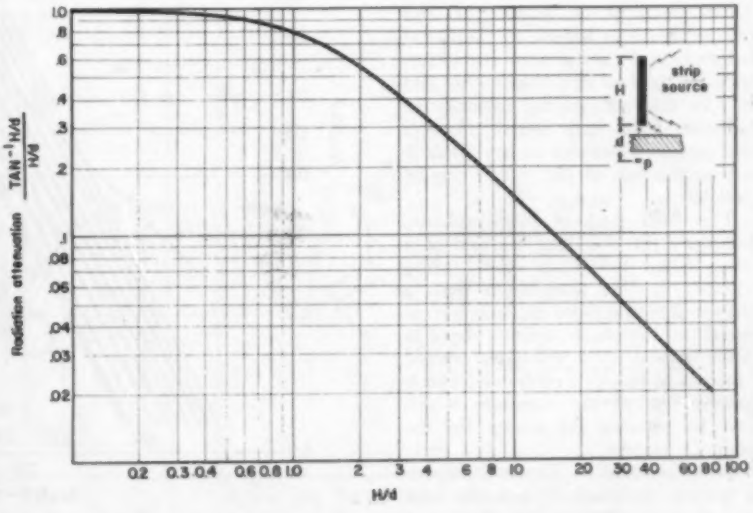


Figure 19. Attenuation due to geometry along axis of strip source.

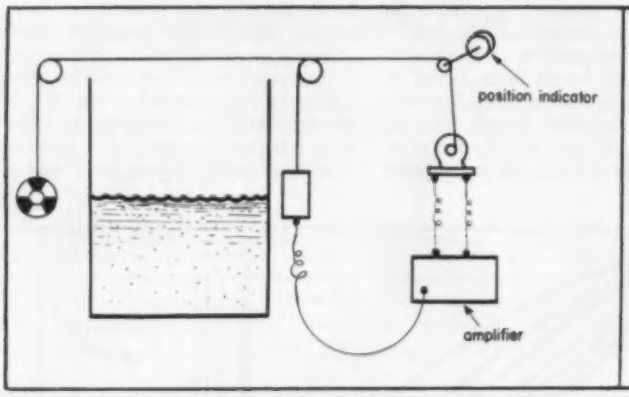


Figure 20. Source and detector follow level to provide measurements of high degree of linearity and accuracy.

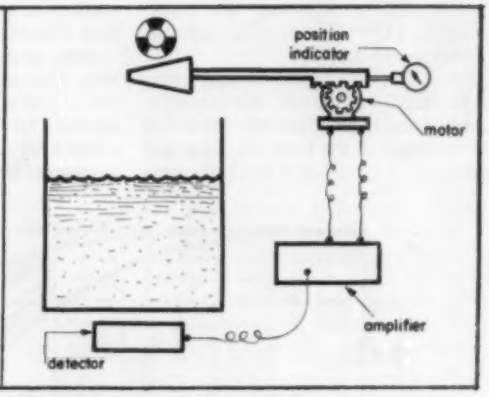


Figure 21. An absorbing wedge can be positioned between source and detector to maintain constant radiation level.

The mean effective actual radiation intensity will be this calculated value multiplied by the correction factor ϕ shown in Figure 17 for the specific H/d ratio and tank wall absorbancies X.

Figure 17 does not include build-up. If build-up is included in the point source calculations of Equation 6, little error will result in neglecting this item in the diagonal interactions.

To calculate the intensity of radiation at a point opposite to one end of a strip source, Figure 16 is used. This is the inverse problem. The equations and results are the same for a point source to a strip detector as for a strip source to a point detector. However, the maximum intensity of radiation from a strip source is opposite its center, not its end. The intensity at points not opposite the end of a strip source is calculated by breaking the problem into two parts and assuming the source AB to consist of two lengths, AC and BC, as shown in Figure 18. The total radiation at P is the sum (or difference) of the two strip sources AC and BC. In this manner the intensity of radiation from strip source through any parallel absorbers to any point P not on the axis of the source can be calculated.

The final part of this problem, necessary for shielding the end of a strip source holder, is solved using Figure 19. The attenuation from a strip source to a point on its axis compared to the same activity from a point source is a relatively simple function of the H/d ratio only, and is independent of the absorbers which may be between the source and the point of interest.

Servo method A. Figure 20 shows a system designed to provide level measurements with a high degree of linearity and accuracy over a long range. The source and detector follow the level. The amplifier drives the servomotor until the detector reaches some set radiation intensity.

Servo method B. In Figure 21 the servo system positions an absorbing wedge between the source and detector to hold a constant radiation level at the detector. If the wedge has a linear taper, its position will be a linear measure of liquid level.

This system has two advantages. The source and detector are stationary and can be mounted permanently. The radiation level at the detector is constant and is as safe when the tank is empty as when the tank is full.

Wedge method. Figure 22 proposes an absorbing wedge mounted to equalize the radiation intensity from a point source at the top and bottom of a long detector. This method may be presumed to give a fairly linear level measurement, but it has not been tried. The calculated thicknesses of the wedge (in absorbance units) are

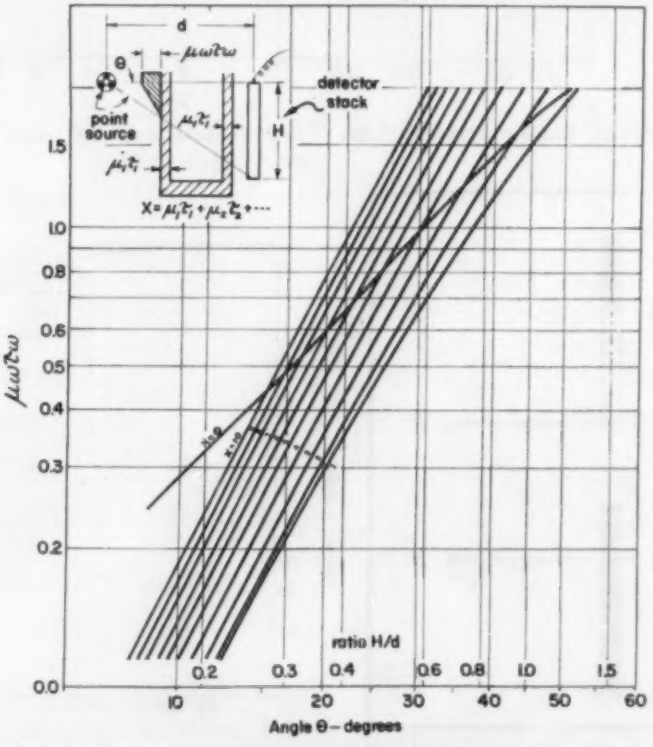


Figure 22. Maximum thickness (in absorbance units) of wedge to give linear calibration from point source for geometry shown.

given for various tank wall thicknesses and geometries.

Density measurement

The arrangement for density measurement may be a source and detector on opposite sides of a pipe or a flow cell as shown in Figure 23. An alternate arrangement is to locate a source inside a tank with the detector external. The problem is to design for a suitable path length τ through the liquid being measured to give an adequate signal and satisfactory noise level without using an excessive source size. The appropriate equations are Equation 5 which gives the intensity of radiation from the source of S millicuries and Equation 6 which gives the intensity at the detector with the empty liquid chamber in place. Two additional equations required for density measurments are

$$I_2 = (1 + \mu_1\tau)\, e^{-\mu_1\tau}\, I_1 \qquad (9)$$

$$I_3 = (1 + \mu_2\tau)\, e^{-\mu_2\tau}\, I_1 \qquad (10)$$

for the intensities when liquid of absorption coefficients μ_1 and μ_2 fill the flow chamber. If the detector has a constant C micro-microamperes per mr/hr., the high and low signal currents will be

$$i_1 = CI_2 \qquad (11)$$

$$i_2 = CI_3 \qquad (12)$$

at low and high density, respectively, and the measuring signal will be

$$\Delta i = i_1 - i_2 \qquad (13)$$

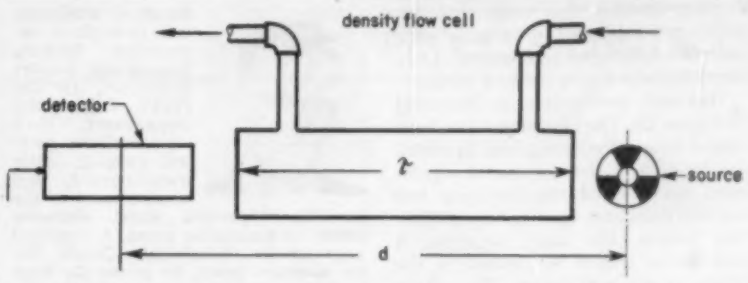


Figure 23. Typical cell geometry for the measurement of liquid densities.

Substituting the equivalents in Equation 13 gives

$$\Delta i = \frac{CKSN}{d^2}\,(1 + X) \qquad (14)$$

$$[(1 + \mu_1\tau)e^{-\mu_1\tau} - (1 + \mu_2\tau)e^{-\mu_2\tau}]e^{-X}$$

which relates the variables to give a desired signal Δi. Designing for specific values of density by Equation 14 will provide an adequate signal which may contain an inacceptable amount of noise. The previous equations can be combined with Equation 8 to give the relation for the noise which should be expected at a given signal level Δi:

$$CKSN\,\theta\,(\text{Noise})^2 = \frac{64d^2}{(1+\mu_1\tau)e^{-\mu_1\tau}(1-e^{-\Delta\mu\tau})^2} \qquad (15)$$

The expression $\Delta\mu$ is the difference μ_1-μ_2. This permits checking a particular design for the noise level which will result. Equation 15 applies only for narrow range density measurements where $\Delta\mu$ is substantially less than μ_1.

Equation 15 is cumbersome for routine use. Experience has demonstrated the following rule-of-thumb values for the minimum path length for various density spans which will roughly satisfy this equation using Cs-137 as a source.

Density span, g./c.c.	Min. path length, in.
.2	1
.1	3
.05	10

Longer path lengths will reduce the noise or allow shorter time constants, and increase the required source size.

Special arrangements

Several measuring problems can be best handled using compensating cells as measuring cells responding to process conditions. Such compensating cells are available matching the usual measuring cells in physical size and output except that the polarity of the signal is opposite. Thus a measuring cell and

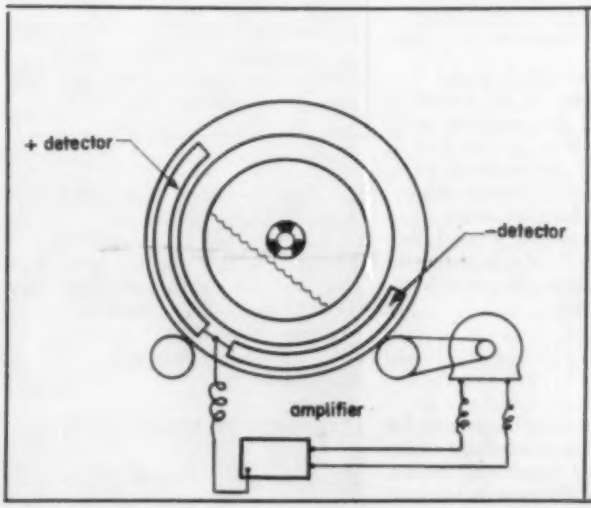


Figure 24. Measuring angle of repose of material in vessel.

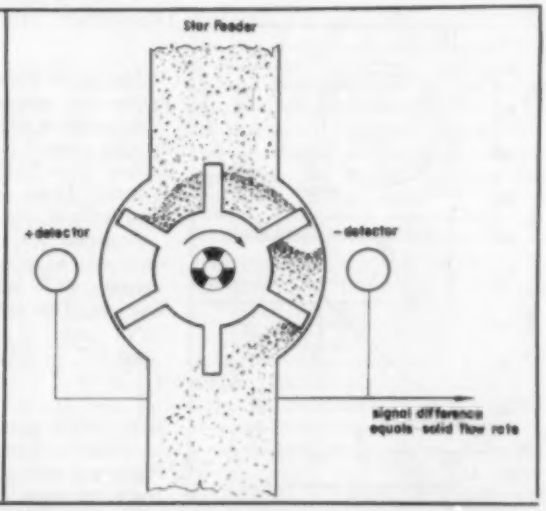


Figure 25. Solids flow rate measurement in Star-Feeder.

a compensating cell connected together and subjected to the same radiation intensity give zero output. Only the difference shows up as a signal.

One such arrangement is illustrated in Figure 24. The equipment is a horizontal rotary processing unit in which the location of the material is significant. An external ring supports two curved detectors, one giving a positive output, the other negative. A radioactive source is located in the center of the equipment. The output of the detectors supplies the input signal to the amplifier which drives the motor and ring to null the radiation signals from the two detectors. The position of the ring is a measure of the angle of repose, viscosity, or other interpretation of the information as may be appropriate for the installation.

Another example is indicated in Figure 25 with (+) and (−) detectors on opposite sides of a Star-Feeder having a source located in the axis of the shaft. The difference in the output of the detectors can be due only to solids actually discharged (if the feeder is turning) and will read zero if both sides are empty or if both sides are full.

Other examples of the use of (+) and (−) detectors have been used. In one case, interface was located by detectors placed to measure density difference between upper and lower phases. In another, concentration was measured by comparing the solution density to a reference liquid at the same temperature.

The gamma gaging techniques will surely expand to cover many measurements in addition to level and density.

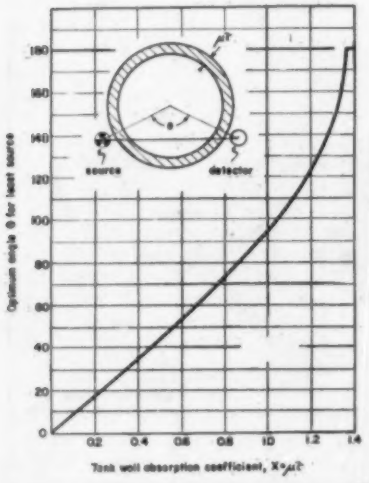


Figure 26. Optimum arrangement for chord across large tanks.



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Optimum arrangements

Several optimum arrangements have been calculated for certain specific situations. One is shown in Figure 26 for the best chord to give the maximum signal from a given source across a tank with a wall absorption of X. For thin wall tanks, a short path length is indicated but care must be taken to obtain a sufficient path length through the process liquid to obtain a satisfactory measurement. The curve shows the maximum signal from a given source when the tank is empty. For tank walls equal or exceeding an absorption value of 1.366, the greatest signal is obtained looking straight across the tank.

The second optimum is obtained by differentiating Equation 14 for best path length for a density measuring cell to produce a specified signal Δi using the least possible source strength. The resulting equation is

$$\frac{2 + 2\mu_1\tau + \mu_1^2 l\tau + \mu_1^2\tau^2}{2 + 2\mu_2\tau + \mu_2^2 l\tau + \mu_2^2\tau^2} = e^{\tau(\mu_1 - \mu_2)} \qquad (16)$$

Referring to Figure 23, l is the distance d-τ, assumed to be constant. This equation will give optimum path lengths around 0.5 for $\mu_1\tau$ for l of 6 inches. (For l=O the optimum path is zero.) These results should not be used without checking for noise.

Equation 15 can be treated the same way to solve for the least source strength while holding the noise level constant. This result

$$\frac{\Delta\mu e^{-\Delta\mu\tau}}{1 - e^{-\Delta\mu\tau}} = \frac{1}{\tau + l} + \frac{\mu_1^2\tau}{2(1 + \mu_1\tau)} \qquad (17)$$

will predict path lengths around 10 in. Unfortunately it says nothing about the signal strength which may be too low to use even if the noise is low.

Another optimum design has been worked out for the least cost to measure level in large tanks with the choice of adding n detectors in parallel and reducing the source size by the factor n. This calculation involves some cost data; the results show that for tank diameters of at least 20 ft. it is always cheaper to increase Co-60 or Cs-137 source sizes and use a single detector.

Notation

- B_f Build-up factor approx. equal to $(1 + X)$, dimensionless.
- C Detector constant, $\frac{\text{amperes} \times 10^{12}}{\text{mr/hr.}} = \frac{i}{I}$
- d Distance from radioactive source, in.
- E Energy, Mev.
- I Intensity of radiation, mr/hr.
- I_o Intensity, air only shielding source, mr/hr.
- I_1 Intensity, empty process vessel shielding source, mr/hr.
- I_2 Intensity, vessel and process fluid shielding source, mr/hr.
- i Detector output, current, micro-microamperes
- K Constant, mr/hr. at one inch, per mc. (varies with source Mev.)
- N Number of gamma photons per disintegration of radioactive source
- n Number of detectors used in parallel.
- R Roentgen. Radiation level to produce 2.08×10^9 ion pairs per cu. cm. of dry air at standard conditions
- S Source strength, millicuries
- τ Absorber thickness, in., or in units reciprocal to μ
- X Absorption due to empty process vessel, jacket, etc. $\mu_1\tau_1 + \mu_2\tau_2 + \mu_3\tau_3 + \ldots$, dimensionless
- Θ Time, time constant, sec.
- μ Absorption constant, per in., or units reciprocal to τ
- μ_W Absorption constant for water, per in.
- ρ Specific Gravity
- ϕ Attenuation Factor. Radiation intensity reduction from strip sources, dimensionless

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Chromatography for process control

Applications of chromatographs in the chemical industry, particularly as process monitors, are becoming legion; however, with the development of high speed units, the future utilization in process control also appears promising.

The techniques are applicable to many operations such as fractionation, extractive distillation, catalytic and chemical reactors, trace analysis, etc.

Investment costs in many operations have been realized within a year due to increased production, improved product quality, and reduced operating costs.



Interior of Consolidated Electrodynamics Corp.'s process chromatograph.

Operating principles

The elution-partition combination is the most versatile chromatographic technique presently available to the chemical industry.

THE GROWTH OF GAS CHROMATOGRAPHY has been phenomenal. Thousands of applications have been found and yet the pace of its development is still increasing exponentially.

Chromatography is particularly important to the chemical and petroleum processing industries because it can be used to increase production, reduce operating costs, conserve raw materials, improve quality, and make new processing methods possible. The yardstick of performance is economic return.

As continuous process analyzers integrated into modern control instrumentation, chromatographs pay for themselves two to ten times a year. Because of its value, people who are responsible for the development, design, and operation of processes need to have an appreciation of the basic principles of chromatography and a knowledge of how it can be applied. This is essential to development and application and to the intelligent interpretation of the results.

Process instrumentation

The chromatographic family is a very large one. In fact, it is so large and diversified that it is almost impossible to find a simple definition for chromatography. Basically it is a method for physically separating a mixture into its chemical components.

A review of the basic methods and types of chromatography are included in this article (see box). The three methods and the three types discussed are combined in various ways to meet specific analytical conditions. Elution,

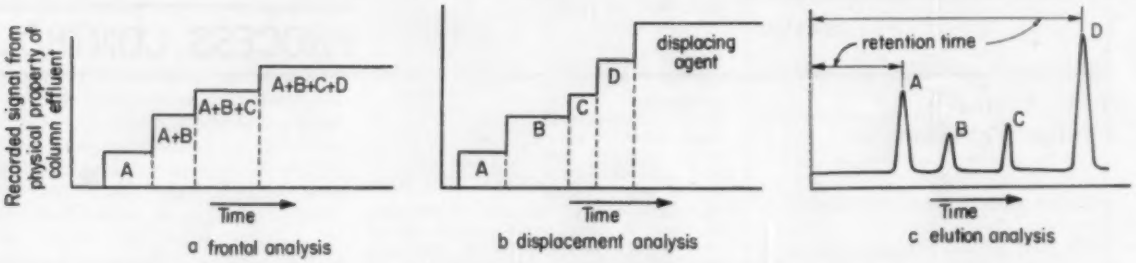


Figure 1. Typical records for the three basic methods: frontal analysis, displacement analysis, and elution chromatography.

displacement, and frontal analysis can be used with adsorption columns, but only elution is applicable to the partition type. Nevertheless, the elution-partition combination is by far the most useful of all.

For continuous process control only one of these elution-partition combinations is of any interest at the current stage of the art. This is the system where the carrier or moving phase is a gas and the fixed phase is a liquid supported on a solid, i.e., a gas-liquid device.

A schematic layout of a process chromatograph is shown in Figure 2. Basically the system is very simple. A carrier gas such as helium, hydrogen, or nitrogen is passed continuously at a constant flow rate through the column. The column is a piece of ¾-in. or ¼-in. diameter tubing several feet long packed with a suitable partitioning material. There is a detector at the outlet which more or less nonselectively responds to a difference in properties between the carrier gas and the components of the sample. There is a wide variety of detectors available.

The sample must be introduced as a small slug of material into the carrier gas as it enters the column. The same amount of sample must be added each time. The column is thermostatically controlled.

Almost anyone can assemble an operating chromatograph from materials available in the average laboratory, but for process control the problem is to obtain the accuracy, reproducibility, reliability, and safe operation required by plant conditions. The simple system must be extensively refined to satisfy these requirements. As a result of this refinement process, a chromatograph will cost from $3,000 to $8,000.

Quantitative analysis

The term "process analyzer," or more specifically "process chromatograph," will be used frequently in the following discussion. It will be well to define its meaning. The process analyzer is an apparatus or set of specially designed fabricated equipment installed in a process to which it is directly connected. It continuously and automatically samples a process stream and determines quantitatively one or more of the components of that stream. It automatically records and displays the results so operating personnel can use it to run the plant. Most important of all, it can be further used for direct closed-loop automatic control.

The operation of a gas-liquid partition chromatograph is cyclic. Each time a sample is introduced it will separate it into its components. In nearly all cases each component will have a different retention time. A continuous recorder on the outlet of the column will make a record somewhat like that shown in Figure 1c. This type of record is sufficient for a laboratory analysis, but for a continuous process analyzer we want to automatically cycle the operations of the chromatograph. This is the function of the programmer shown in Figure 2.

The programmer automatically introduces the sample from the process stream at the appropriate intervals of five to thirty minutes. The time depends on how long it takes the entire sample to pass through the column. The programmer also performs some other functions. An enormous amount of recording paper would be needed to make a record like that shown in Figure 1c each time that a new sample was introduced. Moreover, an operator would have difficulty scanning as much chart as he might like. In most applications one to four components of the sample are of major interest. The others simply clutter up the record. The programmer can be set to choose which component or components are to be recorded and to control the recorder chart movement during recording.

One way of presenting or displaying the analytical results is by bargraph. This, the simplest method for presenting multicomponent results, is shown in Figure 3. It can be readily used and interpreted by operators, but it is obvious that it leaves much to be desired, especially when the number of components is three or more.

Digital data presentation

In spite of its inadequacies and complexity, bargraph presentation is used not only for multicomponent recording, but also for multistream re-

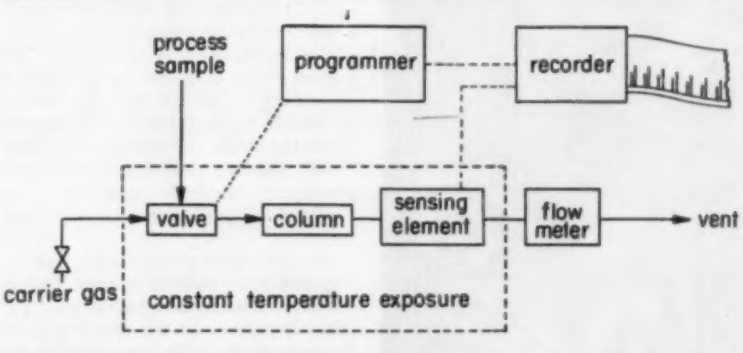


Figure 2. Schematic diagram of standard process chromatographic analyzer.

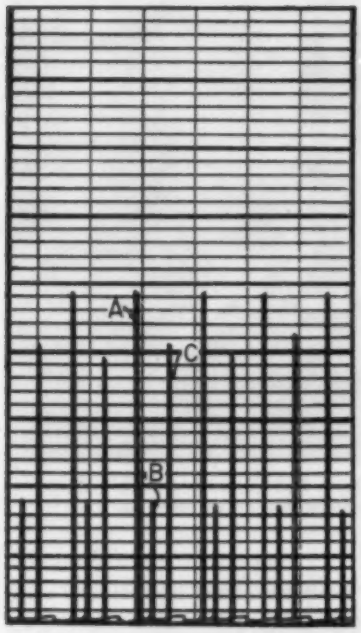


Figure 3. Simple method for displaying analytical results is by bar graph.

cording. This requires considerable judgment on the part of the operator to identify the stream and sample component. Each component must have an individual calibration converting peak height to concentration, which is a nonlinear relationship for wide concentration ranges.

There is a limit to the number of data which can be intelligently presented in analog form. For both pilot plant work and process computer control a different and more complete system is necessary. A data reduction system which integrates each chromatographic peak, calculates a normalized linear percent composition, and types this out in digital form appears to be the most useful. For pilot plant work this provides complete analytical information from the process being studied without requiring a digital computer. This makes it useful for a large variety of small projects.

In connection with computer control, such a data reduction system has several advantages. It conserves computer capacity and storage, it gives an independent system which the computer can sample at will, and being unitized separately from the computer simplifies the maintenance problems. Figure 4 illustrates the data one obtains from such a system in a typical pilot plant study. The chromatogram shown was completed in 50 sec. with a new readout typed every three minutes.

Review of fundamentals

There are three chromatographic methods: (1) frontal analysis, (2) displacement analysis, and (3) elution chromatography.

Frontal analysis.

In frontal analysis, a stream of material to be separated is introduced into the front of a column of adsorbent. As it is passed continuously through the column, the components become segregated. This segregation is a function of the physical characteristics of each component and, to some degree, the nature of the adsorbent. The components come out of the column in the inverse order of their relative affinity for the adsorbent. In a mixture of paraffinic hydrocarbons, the order will usually be methane, ethane, propane, etc. Only the first component is separated from the others. If a nonselective detector such as a thermal conductivity cell is used, the record for an equal percentage mixture of methane, ethane, propane, and butane will look something like Figure 1a where A, B, C, and D refer to the individual mixture components.

Frontal analysis has been used for some years as a field measurement of composition. The method is limited in usefulness because it is difficult to interpret results accurately. This is especially true when a wide range of components is present. Then, too, at the end of the analysis cycle the adsorbent becomes saturated and in equilibrium with the sample. In order to make another measurement, the adsorbent must be replaced with fresh material.

Displacement analysis.

In displacement analysis the material to be analyzed is introduced into the inlet of a column of adsorbent. Then another material, either gas or liquid, is passed through the column continuously. This displacing material must be more strongly adsorbed than any of the components in the sample. As it flows continuously, it drives the sample ahead of it. The components of the sample become separated and arrange themselves in the order of their affinity for the adsorbent. As the displacing material continues to flow, the components come out the other end of the column in succession. With a thermal conductivity detector, the record will look something like Figure 1b. This method is easier to interpret than frontal analysis. However, it is limited by the existence of some mixing interference between the various components. It is also limited by the necessity of removing the displacing agent between analyses.

Elution method.

It is the third or elution method that is the most versatile and widely used. In this method a moving or carrier material is passed continuously through the column. A fixed, known amount of sample is suddenly introduced into the inlet of the column. As the flow of the carrier fluid continues, the sample distributes itself into its components in accordance with their individual characteristics. Ideally they come out the exit end separated somewhat as shown in Figure 1c.

Again a thermal conductivity detector can be used. If the flow of the elutant is constant and the volume of sample is fixed, a quantitative determination of the composition of the sample can be obtained from either the peak height or the peak area. The retention time, i.e., the time interval between sampling and emergence, is used for qualitative analysis.

When suitable adsorbent and carrier materials are chosen, a new analysis can be made by introducing another sample as soon as the last component of the previous sample has emerged.

Types of chromatography

Chromatography can be divided into three types: (1) ion exchange, (2) adsorption, and (3) partition. These describe the material used to fill the column (i.e., the fixed phase) and the physical action that goes on during the process.

Ion Exchange

In ion exchange the column is filled with a resin. This resin must have the well known properties of cation or anion exchange with the materials in the sample which is to be separated quantitatively or qualitatively. This type has been used in the laboratory but not for process control.

Adsorption

In the adsorption type, the column is filled with an active adsorbing material such as silica gel, charcoal, or other adsorbents. This type is frequently used in process control chromatography.

Partition

The partition type is most widely used. In this case the column is filled with a material such as granulated silica gel, kieselguhr, crushed firebrick and the like. A thin layer of a high boiling liquid which serves as the partitioning medium is deposited on these granulated support particles. In process chromatography the moving phase or elutant is almost always a gas.

Monitoring and control

Chromatographs improve plant processes by providing quantitative records for operating personnel. Direct closed-loop automatic control is also becoming practical.

Installing a process analyzer in a plant where its record is constantly available to the operators has proved to be extremely helpful in improving operations. With this record in front of him, an operator can tell "how his plant is doing." He does not have to wait several hours or several days for a laboratory analysis to tell the nature of the material being fed into the process or to learn how good a product he is making. If anything goes wrong, he can do something about it immediately. This minimizes lost production or prevents the manufacture of off-specification material.

Of the several hundred process chromatographs in use today, more than ninety percent are in monitoring service. When a process analyzer is installed, there is an immediate improvement in plant performance because more specific, more accurate, and more frequent information is available to the operator. With the advent of the process chromatograph, process analyzers are approaching the point where it will be possible to eliminate nearly all routine control laboratory work.

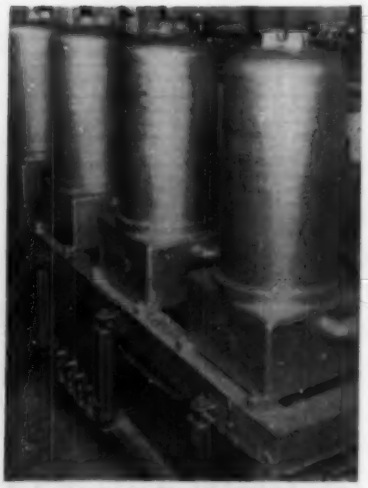
Monitoring with a process chromatograph achieves important advances in process profitability, but there is another natural step which is coming to mean even more. With some additional equipment the analyzer can adjust the process directly instead of requiring the operator to make adjustments every time they are needed.

Automatic process control

Chromatographs are being used to automatically control processes. The number in such use today is relatively small, not more than a few percent. One reason for this, of course, is that it requires some additional equipment as well as greater reliability and extended performance characteristics. The additional equipment needed is commercially available.

This equipment measures the peak height for the component to be used for control and stores this measurement until the next analysis is completed. It then moves to the new value. This peak height output can be obtained either in the form of an electrical or a pneumatic signal. This continuous signal can be used for automatic control.

More than one component can be handled to give simultaneous continuous outputs. Another use for the peak reader is to furnish continuous outputs for monitoring in those cases where continuous records are more meaningful to the operator.

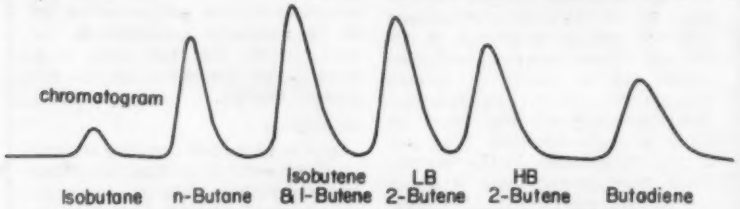


Four CEC chromatographs installed in alkylation unit of Mobil Oil Co.

Since the process chromatograph is cyclic, the concentration of the controlling component may change appreciably between cycles. When the new reading is made, the control signal will suddenly rise to a new value. This sudden change can disturb or jar the system. This limits the extent to which the process chromatograph can directly control a process.

Special techniques are sometimes required in order to achieve the most useful automatic control system. One such technique is called a cascade system of control and is schematically shown in Figure 5. Here a process chromatograph changes the set point of the flow rate controller which controls the reflux into the fractionating column. By properly setting the proportional band (gain) and automatic reset (integral) action of both control mechanisms, by choosing the extent to which the chromatograph readjusts the flow controller, and by placing limits on the range of adjustments a stable or dynamically stable control system can be obtained. Although this scheme is not the best, it will work, and it will improve the control of a process.

A detailed analysis of the situation needs to be made by someone familiar with the practices of automatic control in order to achieve the best design. The five to thirty minute retention time of a standard process chromatograph is a very serious handicap to good automatic control. A lot can happen to a process in this time. However, no corrective action can be



Time	Isobutane	n-Butane	Isobutene & 1-Butene	LB 2-Butene	HB 2-Butene	Butadiene	Total
0302	00311	01429	02322	02267	01962	01693	0999
0304	00311	01429	02321	02251	01981	01694	0999
0307	00312	01430	02321	02257	01980	01695	1000
0310	00312	01432	02324	02272	01963	01699	1000
0312	00311	01431	02323	02256	01978	01696	1000
0315	00312	01431	02320	02256	01982	01697	1000
0318	00311	01433	02326	02275	01959	01699	1001
0322	00312	01432	02324	02255	01985	01701	1001
0325	00312	01429	02318	02253	01977	01696	0999
0328	00311	01429	02320	02269	01958	01694	0998

Figure 4. Total analysis by digital readout system for chromatographs.

taken because the process chromatograph does not know that a change has occurred until it receives the new reading. By this time the system is already in trouble. One axiom in automatic control is that it is much easier to stay out of trouble than it is to get out of it later. This difficulty has been largely overcome by the recent developments in high speed chromatography.

Very high reliability can be obtained with process chromatographs. In our company we have applied a combined process chromatograph and controlling peak reader to the control of a 50 tray, 13-ft. diameter debutanizing fractionator. During a year of automatically controlling the fractionator, only one minor repair was made on the analyzer. It did not require recalibration. The only attention it received was to replace the helium carrier gas cylinder every three weeks.

High speed chromatographs

An extensive study of all the factors affecting retention time, resolution, etc., and the development of special high speed valves and other apparatus has made it possible to decrease retention time to less than one minute, which is 20 to 50 times faster than the standard five to thirty minutes. Figure 6a shows a chromatogram obtained from a standard instrument. Figure 6b shows one obtained from a high speed instrument. Since the high speed chromatograph introduces a delay of less than a minute, it frequently can be used to obtain excellent process control.

Such high speed equipment is commercially available in a form suited to plant installation and their use for direct automatic control is expanding very rapidly. Since they cost only a little more than standard instruments, it is preferable to specify high speed instruments even though they may be initially intended for monitoring service only.

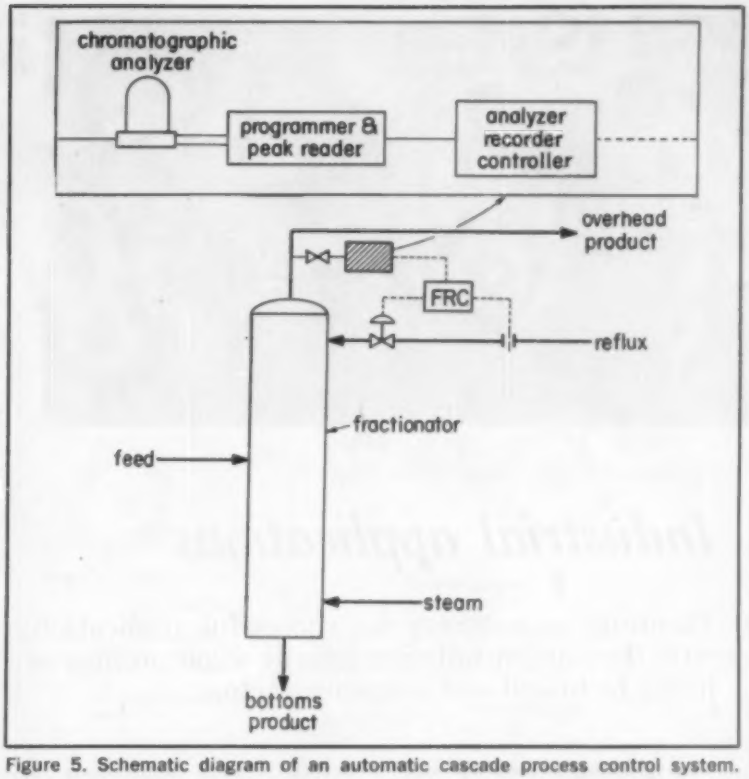


Figure 5. Schematic diagram of an automatic cascade process control system.

Several hundred process chromatographs probably will be purchased in 1960. Perhaps ten percent of these will be applied to direct control of a process.

Sampling systems

Sampling is a problem which must be solved for any installation of a process chromatograph. It is essential that a representative sample of the stream to be analyzed be supplied to the instrument. Solids or heavy liquids which will plug the valve openings and materials which will contaminate columns must be removed. Unfortunately there is no standard way to design sampling systems; neither are there available standard parts from which to assemble them.

A few of the components needed are becoming available. Every problem is different and must be solved by a special study and a special design. Some manufacturers of process chromatographs will design and supply sampling systems to suit the users' needs. At present, the best answer to solving this important problem is for the user to design and build his own system or for the user to ask the manufacturer to quote on and supply the sampling system as a part of the equipment.

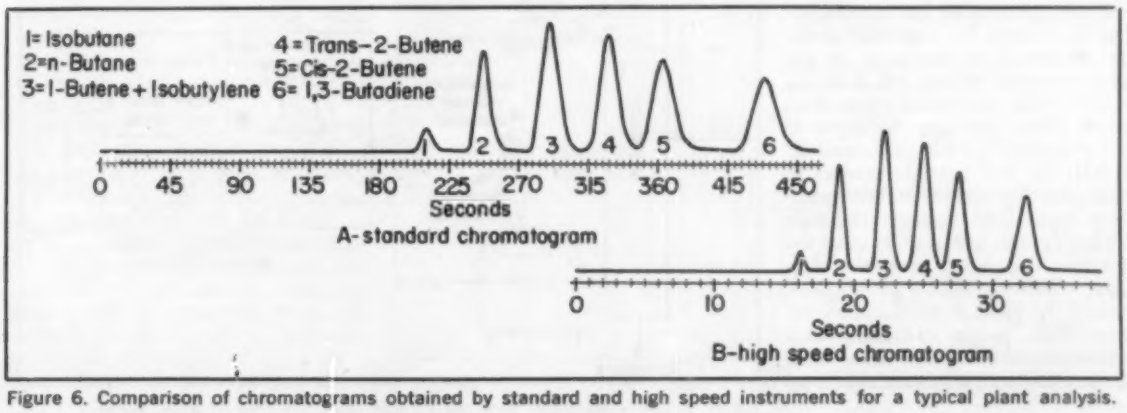
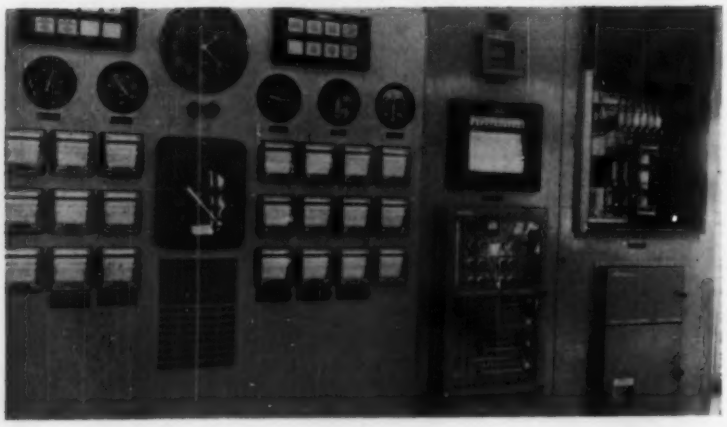


Figure 6. Comparison of chromatograms obtained by standard and high speed instruments for a typical plant analysis.



Beckman gas chromatograph monitors inlet gases, absorber residues, and plant product at natural gas plant.

Industrial applications

Planning is necessary for successful application, with the final installation usually a compromise of many technical and economic factors.

It takes planning to come up with a successful installation of a process chromatograph. The process must be studied to determine what is needed. Then the application of chromatography must be studied to determine how to meet this need. The final answer is usually a compromise of the many factors entering into the final decision.

The objective and purpose of the installation needs to be known and defined as quantitatively as possible. Some of the questions that arise are how many components should be measured? Which components are most important? What is the complete analysis of the stream? Are there materials present which will interfere with the operation of the instrument? Can the sample be vaporized under the conditions of operation of the chromatograph? Where will it be installed? What are the safety requirements? What accuracy is required? Will it be used for automatic control?

With the best possible answers to these questions and others, the instrument applications engineer can start looking for the best way to solve the problem. Depending upon the difficulty, the best answer is obtained through frequent communication between those people who know what is needed and those who know what can be done with a process chromatograph.

Several typical applications of process chromatographs are presented in the accompanying article.

Fractionator control

Fractionation is a very important unit operation. A major oil company will have several hundred large fractionating columns through which pass several hundred million dollars worth of product a year. When an improved control system is designed or better control equipment developed to improve quality, increase production, or reduce operating costs; the result is multiplied many times. Fractionators are usually connected in series with others. Disturbances that upset one will affect all the following ones. If the operation of one is improved, the others will run better and more profitably. Process chromatography has been used to achieve improved control of fractionators.

Figure 7 represents a debutanizer operating on a feed stream of propane, isobutane, normal butane, isopentane, normal pentane, and natural gasoline. From the 9th tray near the top of the tower, the chromatograph receives a sample and analyzes it for propane, isobutane, normal butane, and isopentane. The controlling component is isopentane whose peak provides the signal for corrective action in controlling steam flow to the reboiler. This steam flow control is obtained through a double cascade system by readjusting the setpoint of a temperature recorder controller on the 15th tray.

This installation paid off impressively. It was found to increase the recovery of important constituents (mainly propane and butane) sufficiently to return the cost of the chromatograph every two weeks. It also improved product quality enough to return the cost of the chromatograph every six weeks independent of greater recovery. It further reduced consumption of steam and cooling water so that this saving alone would have paid for the instrument in a year.

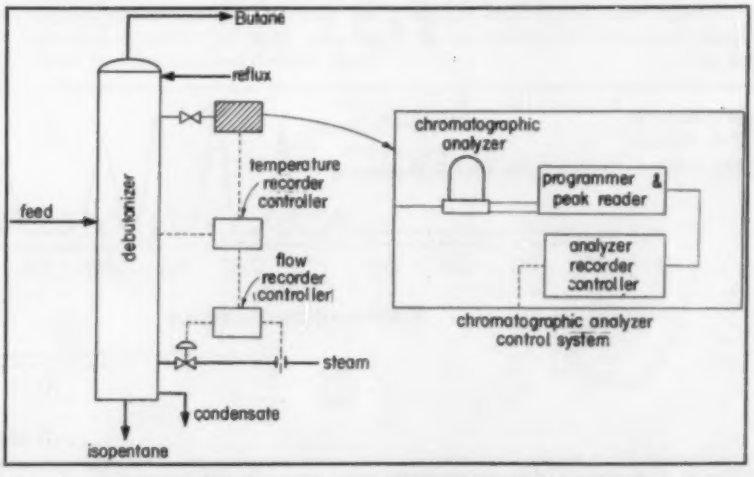


Figure 7. Chromatograph analyzes sample from 9th tray of debutanizer.

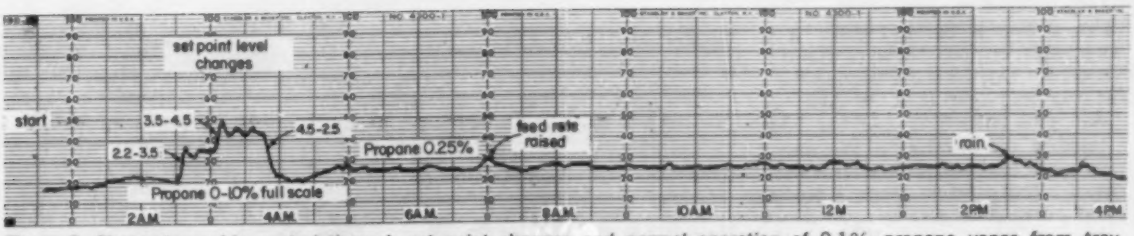


Figure 9. Chromatographic control through set point changes and normal operation of 0-1% propane vapor from tray No. 1.

The 9th tray was chosen as the sampling point because the concentration of the measured components was higher; therefore, the instrument did not need to be too sensitive. It would be much better to sample the overhead product since the concentration on the 9th tray is not always precisely correlated to the overhead product. The performance of process chromatographs has improved since this installation so that it is now possible to analyze the terminal stream.

Correction of deviations

Figure 8 shows a high speed chromatograph controlling a natural gas liquids (NGL) depropanizer. In the depropanizer operation the feed is a composite of raw natural gasoline from several plants in the area. Feed, flow rate, and composition vary widely. The high speed chromatographic analzer maintains propane in the bottoms product at 0.25%.

Figure 9 (consecutive portions of the analyzer recorder controller chart) shows that recovery from large setpoint changes is good. At one point a rain storm occurred. This normally required corrective action by the operator, but it can be seen that the analyzer maintained steady control through this disturbance.

With high speed chromatography, as soon as deviation from setpoint is recognized by the analyzer, no matter what the cause, steps to correct this are started immediately. Operator experimentation can determine what conditions are best to drive a fractionator or absorber just hard enough to meet minimum product specifications.

Since the major disturbances in this system are feed flow and feed composition changes, there is a better way to control this system than the one shown. It would be better to measure the feed composition and feed flow, and on the basis of this information, adjust the column to make the most profitable separation. Then the bottoms product could be trimmed using the chromatographic analyzer for feedback control to reboiler steam.

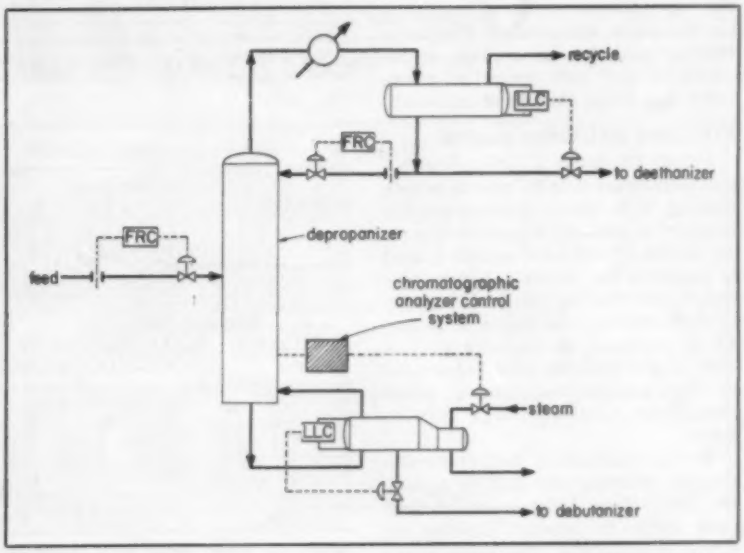


Figure 8. High speed chromatograph controlling NGL depropanizer operation.

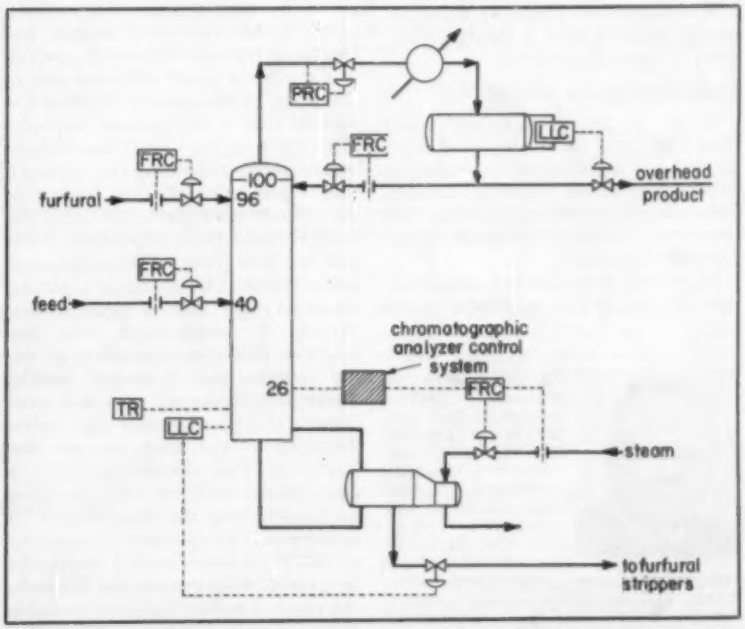


Figure 10. Absorber control system using high speed analyzer as sensing device.

This system is better because it is predictive. It finds out what the disturbances are and starts treating them at just the right time. It does not wait until enough trouble has been stored in the fractionator to cause a change in the bottoms product to initiate corrective action. Such a predictive system could also be applied to a series of fractionators. Without the high speed process chromatograph such predictive control systems would be impossible. To design a system of this type, process studies of fractionator dynamics are needed. Predictive systems can also be applied to reactors or any unit operation where there is a large storage of materials.

Extractive distillation control

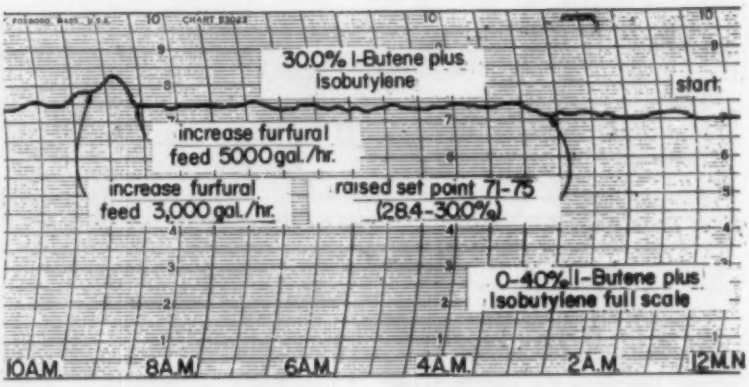
Figure 10 shows a furfural extractive distillation column control system using a high speed chromatographic analyzer as primary composition sensing device. The chromatograph is used to maintain the desired 1-butene plus isobutylene content on the 26th tray of this adsorber. As shown in Figure 11, it maintains an impurity level of 30% ± 3% 1-butene plus isobutylene in the sample tray vapor phase throughout relatively large disturbances.

In this instrument two chromatographic columns are used in series—the first, 30-in. long, is backflushed each cycle to prevent buildup of heavy components. The second one is 40-in. long, and since the heavies do not reach it, it is not backflushed. This application is interesting because it illustrates how adaptable the chromatographic method is for the treatment of special problems.

Chemical reactor control

Sulfur is commercially recovered from hydrogen sulfide removed from natural gas. A portion of the hydrogen sulfide is oxidized to sulfur dioxide. The sulfur dioxide is reacted with the remaining sulfide to produce liquid sulfur and water.

Plant feed flow rate and concentration of the hydrogen sulfide varies so widely that in spite of a sophisticated double ratio flow control system and frequent chemical analysis of the exhaust gases, efficiency was in the range of 85 percent. A plant test showed that a five percent improvement (2½ tons/day) could be obtained by accurately measuring the hydrogen sulfide and sulfur dioxide content in the exhaust stack gases and using the ratio of these two components to adjust air flow rates. This adjustment was automated by means of a process chromatograph with a peak reader, Figure 12, which reads the two analyzed peaks corresponding to sulfur dioxide and hydrogen sulfide. These two signals are sent to a computer which automatically ratios these values and resets the air flow controller. This chromatograph is a dual column analyzer with provisions for backflushing the first column. It is necessary to operate a column up to 300°F in order to stay above the dew point of the sample and the melting point of sulfur. To get a workable system it was necessary to design a special sampling system.



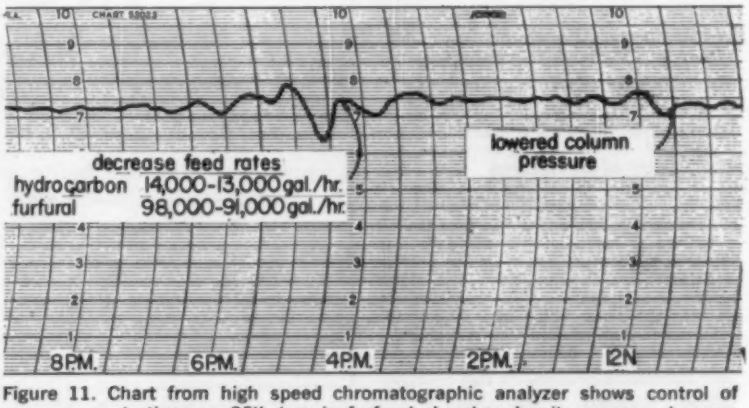


Figure 11. Chart from high speed chromatographic analyzer shows control of vapor concentrations on 26th tray in furfural absorber despite process changes.

Pilot plant operation

There are innumerable ways that process chromatography can be used to improve pilot plant operation. Pilot plants are operated to obtain information. Probably the most important information needed is the analysis of feed and product streams. Relatively limited information can be obtained now because of the large number of man hours required to obtain samples and analyze them. Delay in obtaining this information is very costly because the pilot plant engineers cannot tell whether they are making a good run or whether something may have gone wrong until they receive the results of laboratory analysis.

Correlations are more difficult to make because there is insufficient information and the relationship of cause and effect is distorted by the absence of information, making it impossible to establish when the cause and when the effect occurred. The difficulty in obtaining sufficient analytical results also leads to running the pilot plant operation over a limited range of the variables. Process chro-



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matography can help minimize these difficulties.

An interesting application in the pilot plant involves the use of a ratio computer. Component *A* is the feed to a catalytic reactor where it is partially converted to component *B*. A process chromatograph samples the reactor effluent. Both component *A* and component *B* are monitored and displayed as bargraphs on individual recorders. In addition, both signals are fed to an integrating ratio computer. The ratio of *A* to $A + B$ is the output of the computer. This ratio is displayed as a continuous line on the third recorder. This signal is also fed to an amplitrol, a modulated on-off controller. This then controls electrical heaters on the preheater coils of the reactor to maintain the desired product ratio during each reactor run. Figure 13 shows a schematic of this system.

One of the items needed to make process chromatographs more useful in pilot plant work is a better method of reading out the results.

Trace analysis

In many chemical and petrochemical processes trace concentrations of some materials act as a catalyst poison or reaction inhibitor. In a number of cases chromatography can be used as the basis for a process analyzer for accurate, reliable measurement of parts per million quantities of contaminant.

A typical example is carbon monoxide in ethylene where a two column chromatograph is used. A 100 to 800 ml. sample is passed into the first column. At the end of the sample charge period, helium carrier gas is introduced into the column behind the sample. Ethylene remains adsorbed while hydrogen, oxygen, nitrogen, carbon monoxide, and methane are flushed through the first column and into the second column. These gases emerge through the second column resolved into individual components. There the concentrations are detected and recorded.

During the elution period, ethylene has advanced only a short distance along the first column. When the last trace impurity has emerged from the first column, it is backflushed with helium to remove ethylene and other unwanted components. At 50° C, three hours are required for complete removal of ethylene. More frequent analysis can be obtained by using additional pairs of columns in sequence. The process analyzer is used for monitoring only.

This example shows how chromatography can be used to concentrate

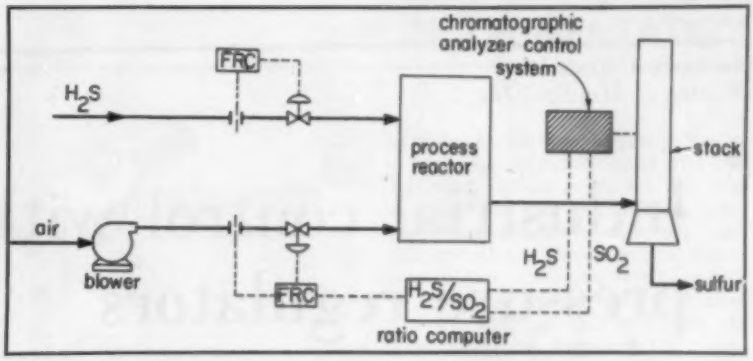


Figure 12. Sulfur plant control system using chromatographic analyzer.

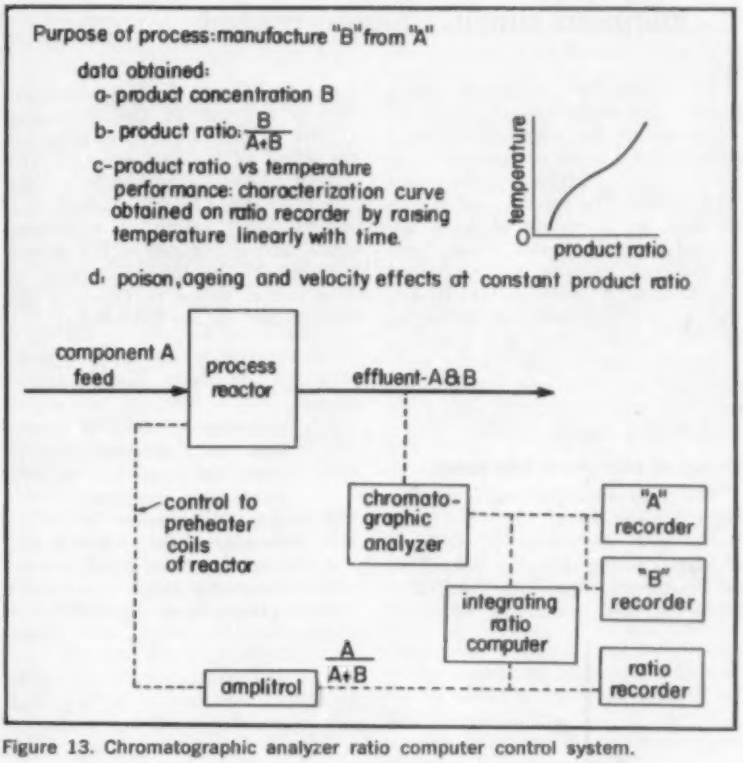


Figure 13. Chromatographic analyzer ratio computer control system.

trace materials so they can be measured. It is not possible to use this technique on all problems of trace analysis. However, the versatility of chromatography is so great that if the solution justifies sufficient study, some way can probably be found to do it.

Conclusion

Today, as always, it is an operating necessity to strive for more profitable operation. Process chromatographs have a relatively untapped reservoir of capacity to improve process performance. Many cases are reported where they pay for themselves in weeks or months. There seem to be almost unlimited applications where they will return their cost in a year or less. These opportunities require time and attention; also the systems engineering to reduce them to a profitable asset.

The opportunities to apply process chromatographs to new process designs look even more promising. Like all advanced methods of measurement and control, the process chromatograph works to best advantage where it is incorporated and integrated with the complete design of a plant. #

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Kieley & Mueller, Inc.

Industrial control with pressure regulators

Knowledge of capabilities and limitations of pressure regulators helps design engineers simplify process control.

THE INCREASING EMPHASIS being placed upon sophisticated control instrumentation has relegated the pressure regulator to the category of hardware. Though it probably is the oldest type of industrial control, and can be replaced by a variety of more advanced methods, it still remains one of the most valuable process-control components. A thorough understanding of the capabilities and limitations of this simple device will enable a design engineer to provide a less complex and less expensive control solution than can be achieved with more sophisticated control methods.

Droop at maximum flow rates

The most important and most frequently encountered single factor in the proper application of pressure regulators is the droop in controlled, or downstream, pressure that takes place as flow conditions approach maximum, Figure 1. This characteristic is a result of the decreasing amount of force required to compress the spring as the flow increases. The amount of droop exhibited by a regulator is governed by three factors: diaphragm area, length of innervalve stroke, and spring rate of the control mechanism. The interrelationship of these factors shown in Figure 2 can be expressed by the following:

$$\text{Droop} = P_o - P_f = \frac{F_o - F_f}{A} = \frac{S\,R}{A}$$

where

P_o = controlled pressure at zero flow (dead-end condition)
P_f = controlled pressure at full flow (wide-open condition)
A = diaphragm area
F_o = reference force at zero flow
F_f = reference force at full flow
S = innervalve stroke
R = spring rate = $(F_o - F_f)/S$

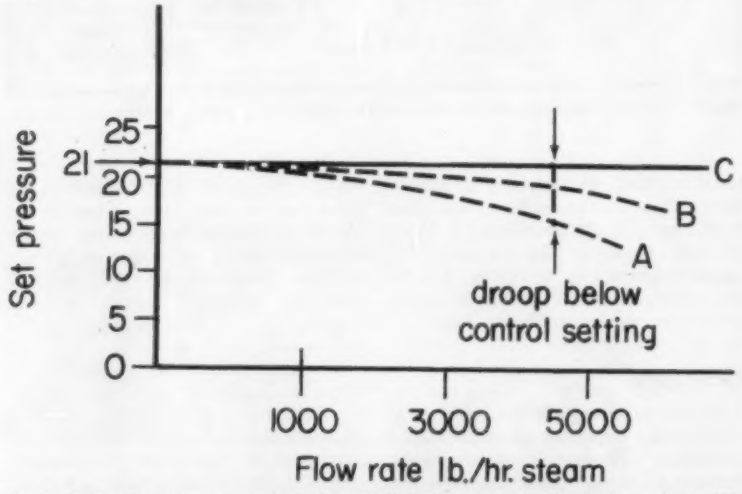


Figure 1. Droop below control setting exhibited by a spring-loaded regulator (A) as contrasted to a weight-loaded unit (B) and perfect regulation (C).

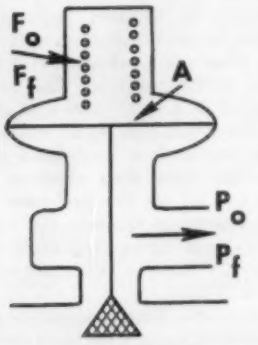


Figure 2. Factors affecting droop.

For reasons to be discussed later, a long innervalve stroke is desirable. The spring rate and diaphragm areas can be adjusted to minimize droop by lowering the spring rate and/or increasing the diaphragm area. Obviously, size and economic considerations limit the diaphragm area and the spring characteristics. Designing a low-rate regulator spring that provides the required high initial loads can result in having a spring so long as to be impractical. However, by replacing the spring with a weight or a volume of gas under pressure, as in weight- or gas-loaded regulators, the droop effect can be minimized or almost completely eliminated.

System variations

Considerable attention must be given to the extent of the pressure variations that can be expected in an application, both on the upstream and downstream sides of the regulator. Appreciable changes in inlet pressure upset the equilibrium of forces that is basic to regulator operation: downstream pressure exerted on the diaphragm area, upstream pressure exerted on the seating area, and the diaphragm reference force, *i.e.* spring, gas, or weight.

In the case of the hydraulically-unbalanced, single-seated regulator, the variation in the hydraulic force on the seating area, caused by fluctuating inlet pressure, changes the force equilibrium. The result is that the downstream controlled pressure fluctuates from the desired setting. In a double-seated regulator, which essen-

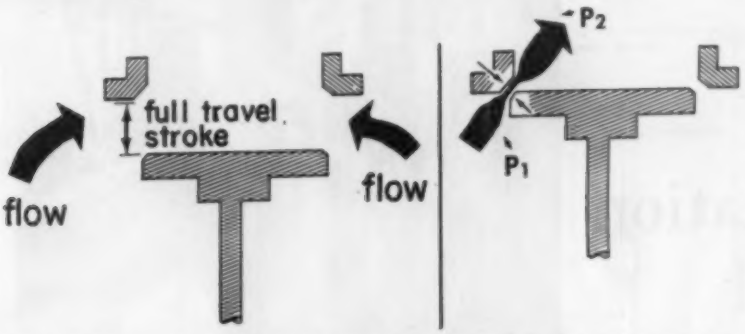


Figure 3. Bernoulli effect. At high lift (left) the velocity is low and pressure is approximately equal. Disc close to seat (right) results in high velocity and low pressure.

tially is hydraulically balanced, the downstream pressure remains constant in spite of sizeable pressure changes on the upstream side.

In applications where double-seated valves can be used, inlet pressure variations pose no problem. However, since more than 50% of pressure regulators are used for dead-end service, a single-seated valve usually is required to provide absolutely tight shutoff. In these applications, the effects of inlet pressure variations can be minimized by using the largest possible ratio between diaphragm area and seat area. The smaller the seating area, the less parasitic hydraulic force is created; the larger the diaphragm, the greater the regulator's capability for absorbing these forces without any adverse effects on the downstream side.

Large, rapid flow variations on the downstream side of the regulator create their own problem, namely, hunting or cycling. This difficulty in finding the proper control point under fluctuating-demand conditions can be corrected by using a high-lift, self-operating regulator with a characterized innervalve. The shorter control loop—and correspondingly faster response to load changes—in the self-operating regulator makes it less susceptible to hunting than a pilot-operated type. The task of selecting the proper self-operating regulator for a particular application is complicated by the fact that high lift contributes to droop in the spring-loaded type and rapid load changes create vibration in the weight-loaded type.

The gas-loaded self-operating regulator, with its fast control response and minimal droop characteristics, usually is the most satisfactory choice where sizeable variations in downstream flow are common.

Shock and vibration difficulties generally are limited to pressure regulators used in systems handling liquids, rather than a compressible medium. They can be traced to one of two primary conditions: the sudden opening of the innervalve against the system liquid, or Bernoulli effects. The first condition is found where the direction of flow assists innervalve closure. A sudden opening of the innervalve against the relatively incompressible system liquid produces hydraulic shock. The only way to avoid it is to use an external, air-actuated, pilot-controlled regulator that permits the direction of flow to oppose innervalve closure.

The Bernoulli effect occurs when the disc operates close to the seat. This causes a large increase in velocity and a corresponding decrease in pressure at the seating area, Figure 3. The resultant force causes premature innervalve closure. When the regulator attempts to correct the situation, a hammering effect is produced. This is an indication that the regulator is probably too large for the application.

Basic engineering

Correct sizing is an indispensable, and usually misunderstood, part of applying pressure regulators properly. A regulator should be sized with the following factors in mind: (1) the required flow for the minimum pressure drop conditions expected, and (2) operation of the innervalve, under normal flow conditions, at 50% to 60% of full stroke to eliminate the wire-drawing and vibration-producing effect caused by operating the innervalve too close to the seat. In applications where a wide difference between maximum and normal flow makes this impossible, two regulators can be used in tandem. The controlled pressure of one regulator is set for the normal flow condition, while the pressure of the second, installed in a parallel line, is set approximately 10% lower. When the inlet pressure in the first regulator drops off due to higher-than-normal demand, the second regulator cuts in to increase the flow capacity without complete loss of pressure control.

Installation of a pressure regulator is considerably simpler than sizing or selecting it. There are certain precautions that should be taken to insure maximum performance. The most important is the location of the control pressure sensing tap so that erroneous pressures caused by turbulence, sudden changes in velocity, or line losses are eliminated.

A special precaution that should also be taken on high temperature gas or vapor applications is the use of a liquid seal, or leg, in the pressure sensing line to prevent the hot gas or vapor from coming into direct contact with the diaphragm. The seal must be compatible with the gas being handled; in vapor applications it is formed by the condensation of the vapor. This seal increases the life of the diaphragm by reducing the temperature to which it is exposed.

The factors of sizing, droop, load variations, vibration, and hunting are the primary considerations in matching a pressure regulator to an application. Because all applications combine at least two or more of these factors, compromises frequently have to be made. The pressure regulator's capabilities are such that they make it possible to arrive at a balance of performance characteristics that fulfills most process requirements with an economy that cannot be matched by instrument-type control. A comprehensive understanding of these capabilities enables the process engineer to profitably exploit the low-cost performance of pressure regulators. ■

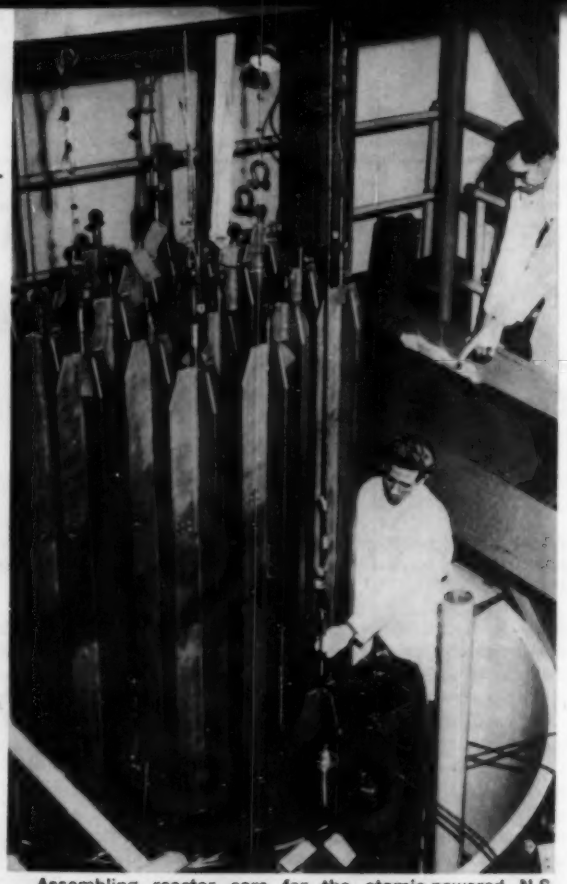


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C. F. Obermesser
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Instrumentation and control of nuclear power plants

Now—practical tips for designing a supersafe control system to handle reactor startup and abnormal operating conditions.



Assembling reactor core for the atomic-powered N.S. Savannah. Suspended above core are control rods used to regulate reactivity. (Photo courtesy Babcock & Wilcox.)

Reliability, flexibility, and safety of operation are the major factors in designing instrumentation and control systems for nuclear power plants.

The basic techniques of accomplishing these objectives in the nuclear power generation field are no different than in more conventional industries. The prevalent philosophy that nuclear reactors must be supersafe has engendered designs of the supersafe variety. In fact, the desire to protect the reactor and the operating personnel is so strong that duplicate — and even triplicate — reactor instrumentation systems are generally provided.

With these criteria in mind, this article proposes to discuss the basic problems and principles involved in the control and instrumentation of closed cycle water nuclear reactor power plants. The various aspects of nuclear power plant operations will be examined in some detail in developing design criteria for their control and instrumentation. Although this presentation deals specifically with closed cycle water reactor plants, a considerable portion of the topics covered are applicable to the philosophy of nuclear power plants in general.

In a closed cycle water-cooled reactor system, Figure 1, high pressure water is used to extract heat from the reactor. The extracted heat is transferred to the secondary loop in a steam-generator system consisting of a boiler and a steam separator. The output loop of the plant contains a steam turbine, condenser, and all the necessary auxiliaries. The turbine is directly coupled to an electric generator. Both the primary coolant and steam systems are closed loops. At equilibrium, there is a direct relationship between the electrical output delivered by the turbine generator and the number of neutrons available for heat generation. Thus, by controlling the number of neutrons reacting per unit volume of uranium, it is possible to obtain rates of heat generation proportional to the demanded electric power output.

In addition to load transients associated with the normal operation of power plants, disturbances arise from abnormal or accidental conditions. If such disturbances were allowed to continue unchecked, serious nuclear reactor and/or plant component damage might ensue. Extreme cases such as too rapid a startup rate, full load rejection, complete loss of station electrical power, and partial or complete loss of coolant flow must be considered in the design criteria for nuclear reactor power plant instrumentation and control systems.

Reactor startup

Normally, reactor startup is the safest operation since it is under direct supervision of the power plant operator. Only two major steps are involved: bringing the reactor to criticality, and then raising the neutron flux value to a level where useable and controllable power is generated.

There are, however, serious deviations in temperature and pressure, which may be caused by faulty or excessive control rod motion, subjecting the plant to uncontrolled ramp additions of positive reactivity of various magnitudes. In order to guard against hazardous operations, control conditions must be established whose parameters may not be exceeded. In turn, the necessary controls must be defined within those limits. The fol-

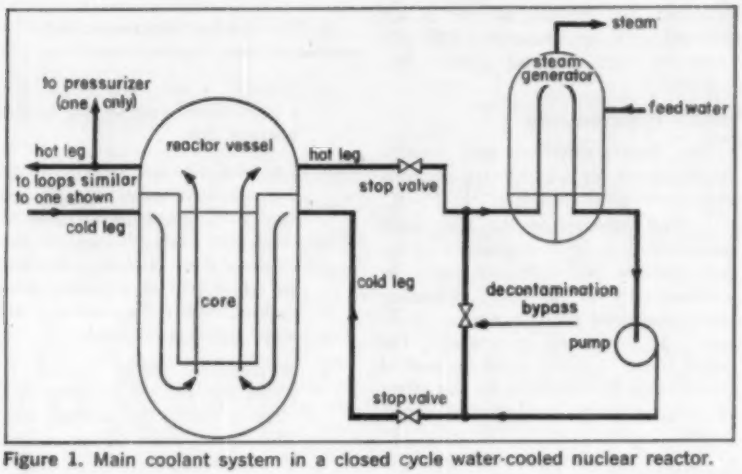


Figure 1. Main coolant system in a closed cycle water-cooled nuclear reactor.

lowing is a conservative definition of these control conditions:

1. Center of fuel melting in the hot channel. (Hot channel is used here to denote that channel in which the fuel heat generation rate is greatest.)

2. Burnout heat flux condition at the surface of the hottest fuel rod. Burnout is caused by steam blanketing, which results in a low heat transfer coefficient at the clad-water interface. This coefficient, in turn, requires a large interface temperature drop in order to maintain the heat flux. Clad melting may result, with subsequent dispersion of radioactivity throughout the primary coolant system. The heat flux at which clad melting occurs is called the burnout heat flux.

3. A limit of pressure, set to be the maximum allowable pressure of the primary system. Conservatively, this upper pressure is set at a point at which the pressurizer safety valve opens. This valve must be sized to handle maximum surge rates.

The closed cycle water reactor has the advantage of a large negative coolant temperature coefficient of reactivity. This coefficient averages as high as -3×10^{-4} $\delta K/°F$. This means that, as the coolant temperature increases, negative reactivity is inserted in the reactor, limiting the rate of rise of the neutron level. Through this mechanism, inherent control is provided and the occurrence of hazardous conditions is prevented. The value of the negative reactivity effect due to the coolant alone is dependent upon the initial coolant temperature.

Reactors using low conductivity fuel benefit from a prompt, sizeable negative fuel temperature coefficient of reactivity. As the fuel temperature increases, this coefficient responds instantly to limit the rate of rise of the neutron flux. Because of the various time constants of the reactor system, the coolant temperature tends to follow the fuel temperature transients for slow ramps of positive reactivity insertion, but lags fast ramp transients. In the latter cases, however, the prompt response of the fuel temperature coefficient of reactivity limits the rate of rise of the neutron flux. This mechanism provides a self limitation of the initial burst in power to tolerable levels prior to initiating external corrective action.

For given negative coolant and fuel coefficients of reactivity, and for initial coolant temperature, there exists a maximum permissible positive reactivity rate which does not yield

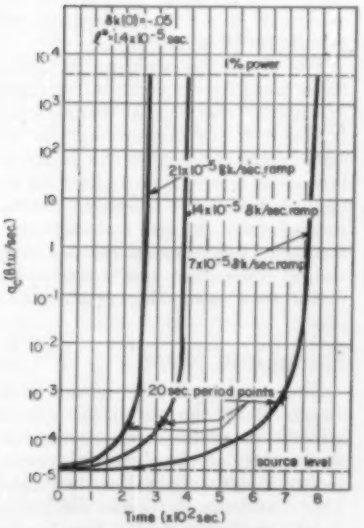


Figure 2. Subpower transients.

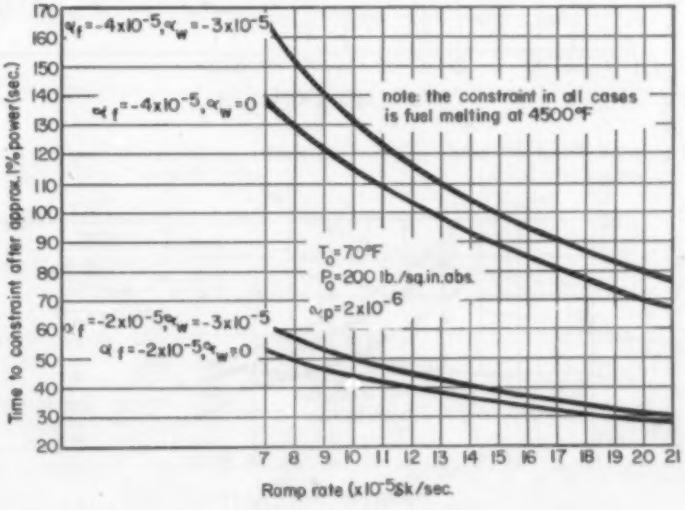


Figure 3. Effect of coolant and fuel reactivities on constraint time.

excessive conditions, at least for the first few minutes of the transient. The startup time to bring the reactor to criticality and the loading rates to bring the plant to useable power necessitate a practical rate of reactivity insertion.

To insure economical plant operation, this practical rate of reactivity insertion is usually larger than the maximum rate referred to previously. A practical reactivity insertion rate, therefore, must meet the requirements for plant startup. It must also provide ample time for external corrective action, in the event of an uncontrolled rod removal. Figures 2 through 7 illustrate this point. They were obtained for various combinations of coolant (α_w), fuel (α_f), pressure (α_p) coefficients of reactivity; initial operating pressure and temperature; and rates of ramp addition of reactivity. The time to reach excessive temperature conditions in relation to different fuel-to-stainless-steel heat transfer coefficients is shown in Figure 6. This is illustrated for various ramp rates of reactivity. Figure 7 is representative of the time available for corrective action, following an uncontrollable rod withdrawal, from source level. If it is assumed that all of the instrumentation signals fail to operate, the point at which localized fuel melting begins is not reached until approximately 260 sec. from the time the rod motion was initiated.

Safety requirements

The instrumentation and control requirements for safe reactor startups must be such that:

1. The controls to the rod drive mechanisms make it impossible to insert positive reactivity—manually or automatically—at a rate exceeding that considered safe for reactor startups. As indicated previously, the initial burst in power must be limited to tolerable levels solely by the effect of the reactivity temperature coefficients.

2. The magnitude and rate of change of the neutron flux is monitored at the reactor console. This must extend from source level to power level, with adequate overlap between the various instruments so that continuous information is supplied. The neutron flux instrumentation channels must be duplicated to provide for the possibility of failure in any one channel.

3. The nuclear instrumentation is provided with circuitry which:

a. Initiates a rod stop signal for a preselected rate of rise in the neutron flux.

b. Reverses the rod motion to insert negative reactivity if the "rod stop" proves insufficient to limit the rate of rise of the neutron flux. This signal must be set to trip at a point above that at which the control "rod stop" signal is initiated.

c. Actuates a safety signal to scram the reactor for excessive rates of rise of the neutron flux. This signal must be set to trip at a point above that at which the control rod insertion signal is initiated.

d. Actuates a safety signal to scram the reactor at a point corresponding to a preselected magnitude of the neutron flux, set below the point at which a limiting condition occurs.

4. The opening of the circuit to the rod drive mechanisms releases the rods, causing them to fall by gravity in the reactor. Two circuit breakers or contactors in series should be provided in the circuits to the rod drive mechanism power supply, with each device receiving the trip signal from both instrumentation channels. This arrangement increases the system reliability and largely decreases, if it does not eliminate, the probability of scram failure.

For a startup accident to occur, there must be a series of multiple failures in the nuclear instrumentation and scram system; and, at the same time, there must be contributory gross errors or negligence on the part of the reactor operators. An instrumentation system which meets the above requirements reduces detrimental consequences of a startup accident to a purely hypothetical concept.

Normal load control

The magnitude of normal load swings about the steady state is essentially dependent upon two factors: the capacity of the plant with respect to the interconnected system as a whole, and the method of load regulation on the system. The loading

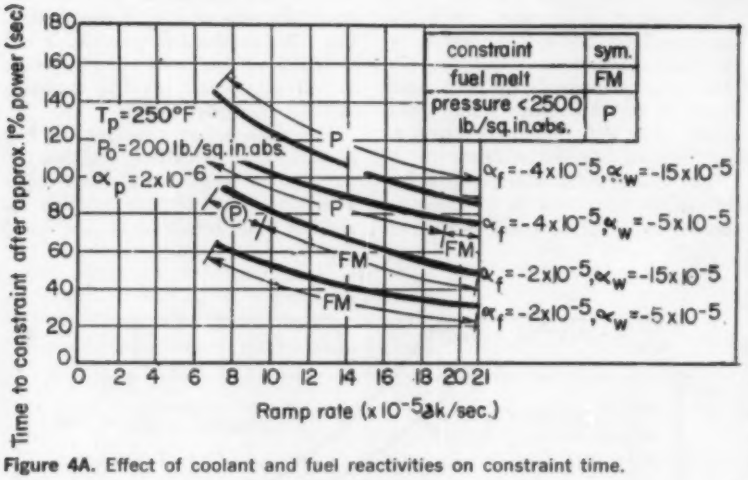


Figure 4A. Effect of coolant and fuel reactivities on constraint time.

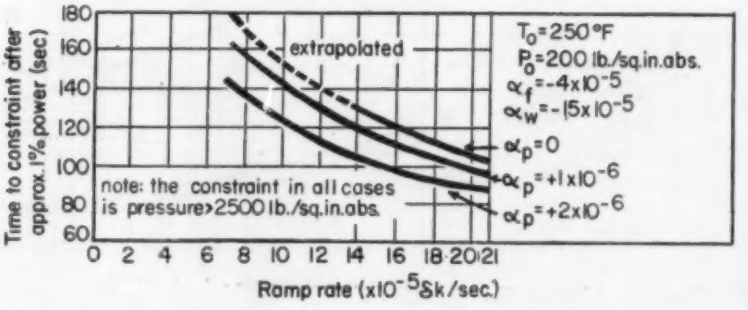


Figure 4B. Effect of pressure reactivity variation on constraint time.

and unloading rates are limited by the turbine governor control and thermal stress considerations in the turbine system. In large power stations, loading and unloading rates of 2-5%/min. are common. Such rates are not considered as limiting values for the safe startup of steam turbines, but are typical of those used in most power stations.

The characteristics and complexity of instrumentation loops that satisfy the reactor control requirements are not only a function of the rate and magnitude of load variation at the turbine-generator, but are also a function of the mode of control used for the reactor system. In any case, the control system must limit the temperature and pressure variations consistent with the design limitations of the components and/or systems affected by the transient. It must also satisfy the requirements for adequate dynamic stability of the entire nuclear reactor power plant.

The strong coolant negative temperature coefficient of reactivity is an important characteristic of closed cycle reactors and has, in the past, formed the basic premise for the reactor system preferring a constant system average temperature mode of control. In considering the use of low conductivity fuels and the subsequent wide variation in fuel temperatures with load, one must take into account the reactivity effects of the Doppler coefficient. In fuel elements containing large amounts of U-238, rising temperatures in the fuel result in a reduction in the resonance escape probability. This contributes a negative reactivity. A typical value for this reactivity effect would be -3×10^{-5} $\delta K/°F$. While the value of this coefficient is smaller (by a factor of 10) than that of the moderator, average fuel temperature changes of the order of several hundred degrees must be considered in going from no load to 100% power.

Figure 8 illustrates the characteristics of a plant regulated only by the effects of its coolant (moderator) and fuel temperature coefficients of reactivity. The curves have been idealized for steady state values corresponding to various load power levels where T_h is the reactor outlet temperature, T_{av} is the primary system average coolant temperature, T_c is the reactor inlet temperature, and T_s is the steam-generator shell side steam temperature. The significant point here is that as the load is increased and a higher heat flux or heat output is required from the reactor, the fuel

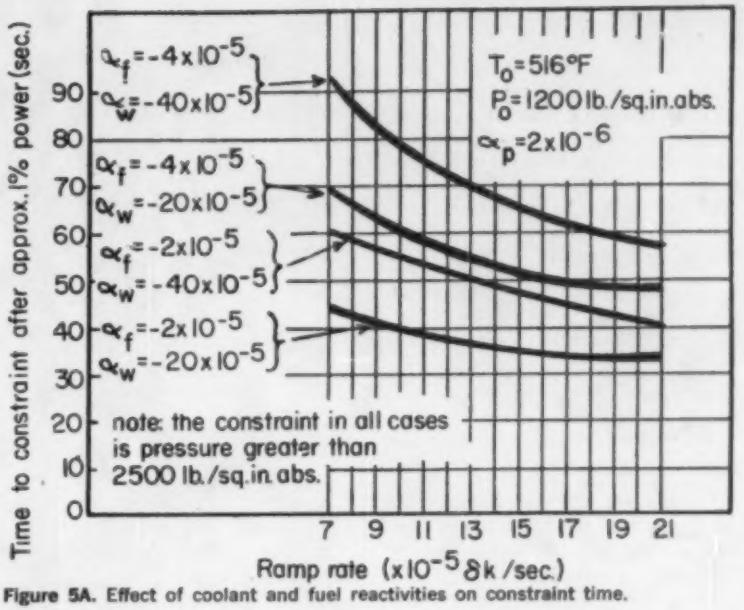


Figure 5A. Effect of coolant and fuel reactivities on constraint time.

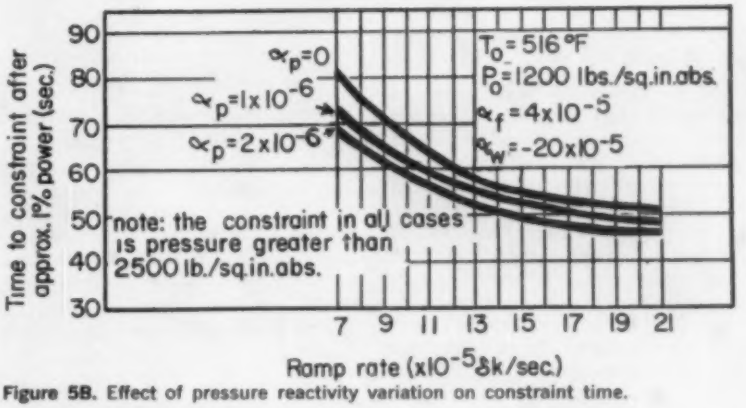


Figure 5B. Effect of pressure reactivity variation on constraint time.

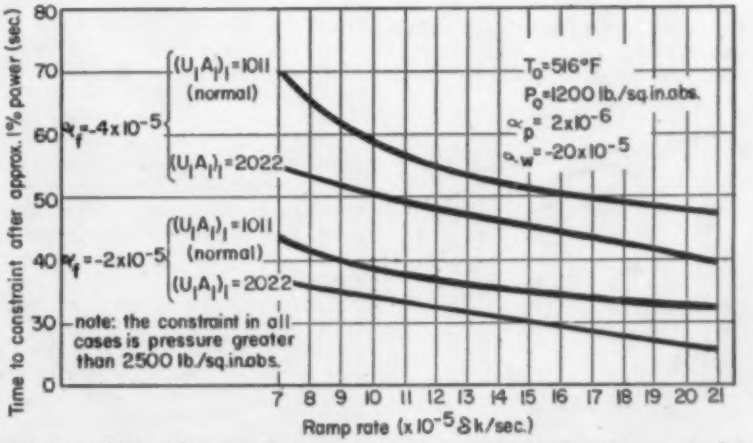


Figure 6. Effect of fuel to stainless heat transfer parameter (U_1A_1) on constraint time.

temperature must also increase. The amount of such fuel temperature increase is almost directly proportional to the load demand, since there is no appreciable change in the coefficient of heat transfer. The negative reactivity introduced by this change in temperature is inherently compensated for by the change in moderator temperature. The self-regulation program, however, presents these advantages:

1. It does not depend on the action of instrumentation loops to control the reactor during load transients.

2. It reduces the amount of shutdown reactivity required at zero power and operating temperature.

The following are some disadvantages of the self-regulation program:

1. Rapid temperature changes in the plant may result for normal turbine loading and unloading rates, as well as for electrical transmission system transients at the turbine generator. This may introduce thermal stress problems, as well as a need for accommodating the attendant large rate of change of coolant volume in the primary system.

2. An increase in the capacity of the reactor coolant charging and volume control system, and/or an increase in the size of the pressurizer may be a consequence of this mode of control. Economically, the normal capacity of the charging and volume control system is predicated from such considerations as: normal reactor plant heat-up and cool-down rates; normal, as well as preshutdown, purification rates; and required chemical neutron poison removal rates, if such poison is necessary to maintain subcriticality in the cold clean reactor.

3. The over-all plant efficiency is lowest at high power levels. Also, the steam plant must be designed and its components sized for high temperature and pressure conditions which

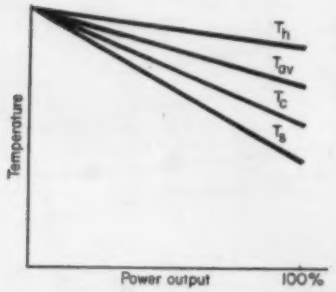


Figure 8. Temperature variations for a self-regulating plant program.

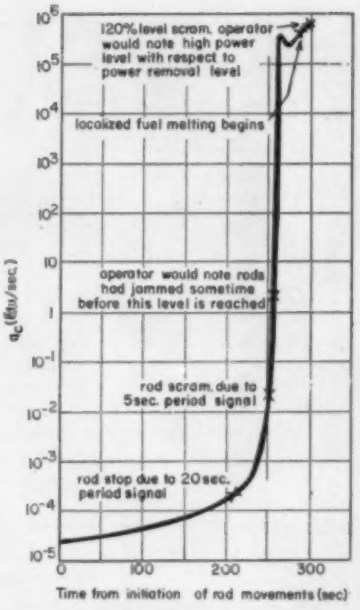


Figure 7. Transient response for bad startup accident from source level.

exist at low power levels, under which the plant is least likely to operate.

External instrumentation control

Figures 9 through 11 illustrate various modes of reactor control that may be achieved by means of external instrumentation loops. Each has its advantages and disadvantages. Any decision as to the type of control to be used is primarily dependent upon over-all system operational characteristics and economic considerations.

Where reactors with small Doppler temperature coefficients of reactivity are concerned, the constant average temperature program follows most nearly the inherent characteristics of the reactor and requires the least amount of external control. This is the program preferred by the reactor designer since the volume of coolant in the primary system is essentially constant and a minimum pressurizer size is possible. However, large steam pressure variations occur over the power range and the secondary steam system must be designed to cope with such variations.

Another extreme in plant programming is to hold the steam pressure constant as a function of power level, and permit the primary system temperatures to rise. This program permits optimum design of the steam plant. On the other hand, large reactivity change is required because of the variation in the main coolant average temperature. This may introduce serious pressurizer sizing problems, as well as necessitate unusual rates of reactivity insertion through control rod motion.

The constant inlet temperature program is a compromise between the two above programs in that it is part way between these two extremes.

The pressurizer is one of the major reactor plant components. Its prime function is to establish and maintain a nominal operating pressure, but its design has a certain interdependency with the control system requirements. Volume surges resulting from temperature changes in the primary system are reflected in a change in water level in the pressurizer. Positive pressure changes must be limited to a value less than the normal operating system design pressure, otherwise safety valves will open as part of their normal operating procedure. Similarly, negative pressure changes must be confined to a certain magnitude in order to limit the amount of boiling in the reactor. These changes are dictated by thermal considerations associated with the safe operation of the reactor core.

Abnormal operating conditions

A full load rejection at a nuclear power plant would essentially represent a limiting condition insofar as the worst possible load transient is concerned. Either this rejection is of very short duration, and normal conditions are re-established within a very few cycles; or it is such that the network relay system operates to isolate the plant and trip the turbine-generator unit, constituting a complete loss of power. In the first case, the thermal inertia of the various systems connecting the nuclear reactor (primary plant) to the steam turbine (secondary plant) is such that very little effect, if any, is felt; and no particular controlling action is necessary. In order to suit the first condi-

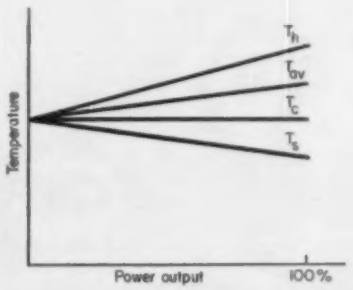


Figure 9. Temperature variations for a constant steam temperature program.

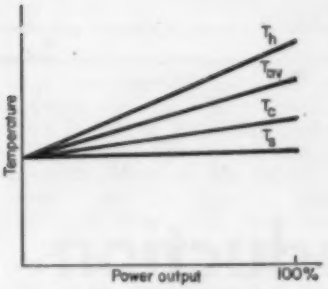


Figure 10. Temperature variations for constant avg. temperature control.

tion, protective instrumentation concepts must include adequate time delay to preclude the occurrence of expensive and unnecessary plant shutdowns. In the second case, however, action must be taken early enough to shut down the reactor, in order to prevent dangerous temperatures and pressures which, in turn, may lead to any one of the limiting conditions defined earlier.

Reliable instrumentation must be provided to insure prompt reactor shutdown. If the loss of power to the plant is of long duration, and availability of auxiliary power to the plant depends entirely upon the availability of incoming lines, adequate measures must be taken to insure the continued distribution of power to such auxiliary systems and components as are deemed essential, during the decay heat phase.

Complete loss of power to the station is an accident of serious magnitude in that it is accompanied by the loss of the main coolant flow. Fortunately, it is the least probable accident. Nevertheless, if it does occur, the reactor must be scrammed without delay. Safety signals must be provided to guard against the possibility of failure in any one instrumentation channel. The instrumentation system which causes the trip-out of the turbine should also initiate the reactor scram. As a backup measure, such primary plant parameters as low flow and high pressure should operate on the scram system at preselected values. Unless mechanically driven pumps are provided for emergency decay heat removal in the primary loop, the plant must be designed to allow for adequate natural circulation of the coolant. It is also necessary to provide for feed water in the steam generator; and an emergency feed water pump must be installed.

Conditions involving the loss of the turbine generator alone are far less serious than total loss of power. Although they correspond to a full load rejection, as seen by the reactor, incoming power to the plant is still available for feeding the essential auxiliary loads. In this event, the reactor core and other plant components are protected through the sole effect of the coefficients of reactivity.

In evaluating the effects associated with such accidents, one must consider the inherent contribution of the negative coolant temperature coefficient of reactivity which limits the magnitude of the deviations. In this case, the presence of a sizeable fuel temperature coefficient of reactivity reduces this contribution to an extent which depends directly upon the relative magnitudes of these coefficients. The former is usually much larger than the latter, so that an equilibrium condition is reached at temperatures of the fuel and moderator below a point where the fuel center melting or burnout of the cladding would occur. This equilibrium condition represents a reduced power level of the reactor and is maintained by the opening of the generator steam safety valves, thus providing a heat sink. Through this mechanism, even if multiple instrumentation failure is assumed, ample time is available for the plant operator to take the necessary corrective action and shut down the reactor.

Summary of safety criteria

The following design criteria are indicative of steps that should be taken to provide reliable protection against the occurrence of the above accidents:

1. The plant distribution system should, if at all possible, include two separate sources of incoming power. The station's essential auxiliaries should be divided between three bus sections, energized separately by each one of the incoming lines and the station turbogenerator respectively.

2. The loss of any one, or both, incoming lines to the station should not cause the turbine admission valves to trip out.

3. Any signal that causes the turbine steam admission valves to trip out should initiate reactor shutdown.

4. Dangerous low flow conditions in the reactor primary system must initiate reactor shutdown. This signal serves as a back up to the shutdown signal resulting from complete loss of power to the station.

5. A high neutron flux level, as detected by the nuclear instrumentation, should initiate reactor and turbine shutdown. Three nuclear instrumentation channels should be provided for power operation of the plant. Coincidental high neutron flux—reading from any two of the three channels—would cause the initiation of the shutdown signal. This arrangement precludes the occurrence of false shutdowns through possible malfunction of any one of the three channels.

6. A separate instrumentation bus should be provided to energize those instrumentation systems upon which the safe operation of the plant depends. This bus should be fed from the battery system through a separate motor generator set. This arrangement insures continuous operation of such instrumentation, unaffected by any conceivable plant transients.

In summation, nuclear reactor power plant safety is a function of careful design, adequate controls, and positive instrumentation which instantly detects irregular operating conditions and provides automatic corrective or remedial action. It is the responsibility of the instrumentation and controls design engineer to insure that such effective safety measures are simple, foolproof, and absolutely certain in operation. These criteria must be met if nuclear power plants are to compete successfully with conventional installations. #



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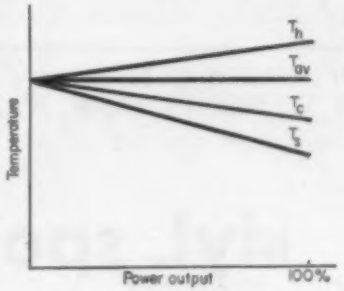


Figure 11. Temperature variations for constant inlet temperature control.

J. Celada & G. H. Muller, *Fierro Esponja, S. A.*
E. W. Riblett, *The M. W. Kellogg Co.*

HyL sponge iron production

Better steel at minimum cost with currently available raw materials now possible with the flexible HyL gaseous reduction process. Units ranging in size from 100 to 2000 ton/day can be operated economically.

The impact of changing technology on different areas of the steel industry is gradually becoming evident. Its effect on scrap use, steel plant size, and raw materials will be briefly discussed here.

Instability of the scrap market is known to the steel industry through its effect on the economics of the operation. Within the plant, use of scrap requires costly handling operations and capital tie-up in scrap inventory and scrap preparation facilities. All the necessary equipment employed in the modern scrap yard makes it a virtual manufacturing plant. A survey made early in 1953 by the Institute of Scrap Iron and Steel disclosed that the investment per annual ton in scrap yards in the United States approximates 7.5 dollars, on a 1-shift, 5-day week basis. Furthermore, when scrap is used in high proportions, variance in its composition imposes an almost unsurmountable problem to the proper quality control of steelmaking. Rusted scrap is suspected of introducing hydrogen to the steel which carries through to the ingot and causes defective steel.

More than nine-tenths of the total world steel production is obtained via the classic iron blast furnace. The capital structure of a new steelmaking plant is such that it is generally found economic to build the blast furnace only if its size exceeds 1000 ton/day. This size plant, with its associated raw materials preparation facilities and finishing equipment requires a huge capital investment.

The inherent flexibility of a HyL gaseous reduction plant permits the economic operation of units ranging in size from 100 ton/day up to 2000 ton/day or more, thus opening new ways of integration to the small steel producer.

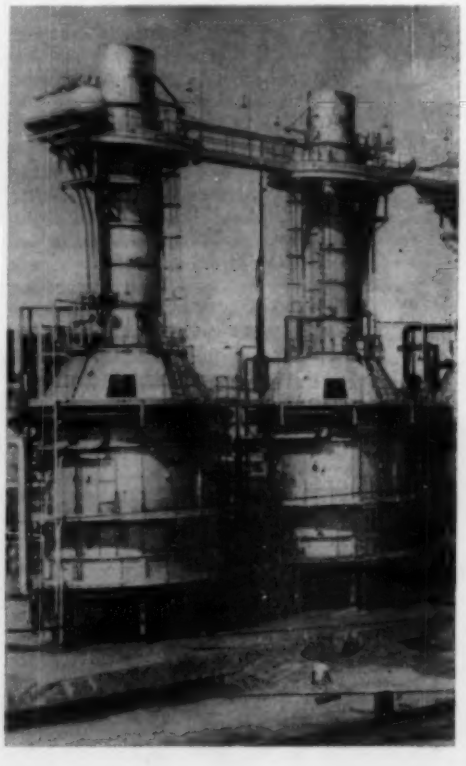
Coke can be made only from certain coals having special properties and characteristics, especially those regarding volatile matter, ash, and sulphur content. Unfortunately, these coals exist in few parts of the world. Only where iron ore and coking coal exist in reasonably close proximity can a blast furnace development have a favorable and stable economic ground. The extreme scarcity of such locations and the economic pressure towards decentralization of iron and steel plants into smaller units are the reasons for the great interest of the steel industry in methods of iron production like the HyL process. Natural gas, being a more abundant source of fuel than coking coal, offers more opportunities for steel development in different areas of the world. Enlargement of this present territory might be expected if the economics of gasification of heavy fuels and coal is successfully solved. Figure 1 gives a comparative representation of the fields of application of the HyL and blast furnace processes.

The HyL sponge iron process derives its name from the Mexican steel manufacturing company, Hojalata y Lámina, S.A., who developed the process at their works in Monterrey, N.L.

Several sponge iron producing methods were tried in Monterrey, but none of them was able to produce sponge iron at a cost low enough for economical use in low-carbon steel production. In the development work, the firm received engineering assistance from the M. W. Kellogg Co., in relation to the natural gas reforming furnaces which supplied the reducing gas used in the HyL process.

The Monterrey works

Production facilities in Monterrey are operated by Fierro Esponja, S.A., an affiliated company of Hojalata y Lámina. To date, the firm has pro-



The new 500 ton/day sponge iron plant at Monterrey. Left are the reforming furnaces, right the reduction reactors.

duced more than 150,000 metric tons of sponge iron which have been converted into first quality rolled product in Hojalata y Lámina's mill. The inherent flexibility of the process is indicated by the fact that plants from 30 to 500 ton/day have been, or are, in continuous operation at Monterrey. A flow-sheet of Fierro Esponja's facilities is shown in Figure 2.

The Monterrey works can be divided into four different areas: ore preparation, 200 ton/day sponge iron plant, 500 ton/day sponge iron plant and experimental pilot plant.

Ore preparation. Fierro Esponja has been integrating its ore preparation facilities. Iron ore is unloaded from 50-ton railroad cars from whence it is automatically conveyed through the crushing and screening plants. Size fraction ranging from ¼ to 2 in. is stored in an adjacent ore yard where it is kept separated according to the different types in use. Temporarily, fines are being stored until the ore agglomeration unit is completed.

Intense experimentation is presently under way in the agglomeration of ore fines. Mainly, two types of processes have been tried out with relative success in a pilot plant stage, vacuum extrusion and disk pelletizing. Although no final results are available, vacuum extrusion requires lower capital investment per unit of output than any other agglomeration method, and the operating costs may also be lower. The reason for this is probably the fact that most minus ¼-in. ore fines can be readily extruded without any further grinding. Also, air dried or moderate-temperature furnace-dried extrusions exhibit enough mechanical strength to withstand the subsequent handling without undue breakage. Ore fines used at Monterrey show enough plasticity to be extruded directly, but the addition of 0.5-1% binding material markedly increases the mechanical strength of the agglomerates.

Although pelletization is a very cheap operation in itself, it offers the disadvantage that the material has to be carefully prepared as far as its fineness is concerned. Pellets made from ore fines not sufficiently ground will exhibit too much degradation in subsequent steps of handling and charging into the reactors. Tests have been conducted with a disk type pelletizer which offers the unique advantage of a uniform pellet size. The economics of large scale production of agglomerates are being studied in detail to provide the best design basis for the future agglomeration plant.

Coarse ore from the screening stage is selectively treated according to its sulphur content as reported from the mining operation. Ores ranging lower than 0.15% sulphur are sent directly to the sponge iron plant for reduction. Ores with more than 0.15% sulphur are roasted before the reduction stage. The above limit in sulphur content has been established by experience so that the sulphur content in the molten metal will usually fall within specifications and require no sulphur refining.

Ore from a high-sulphur deposit is roasted in a battery of four shaft furnaces fed by a common hopper. This reduces the sulphur content of the ore down to proper levels for steel making. Some conversion of magnetite into hematite is also obtained in these roasting units, which improves the reducibility of the ore to a certain degree. After roasting, the ore is screened once again to remove the fines produced during its descent through the shaft furnace.

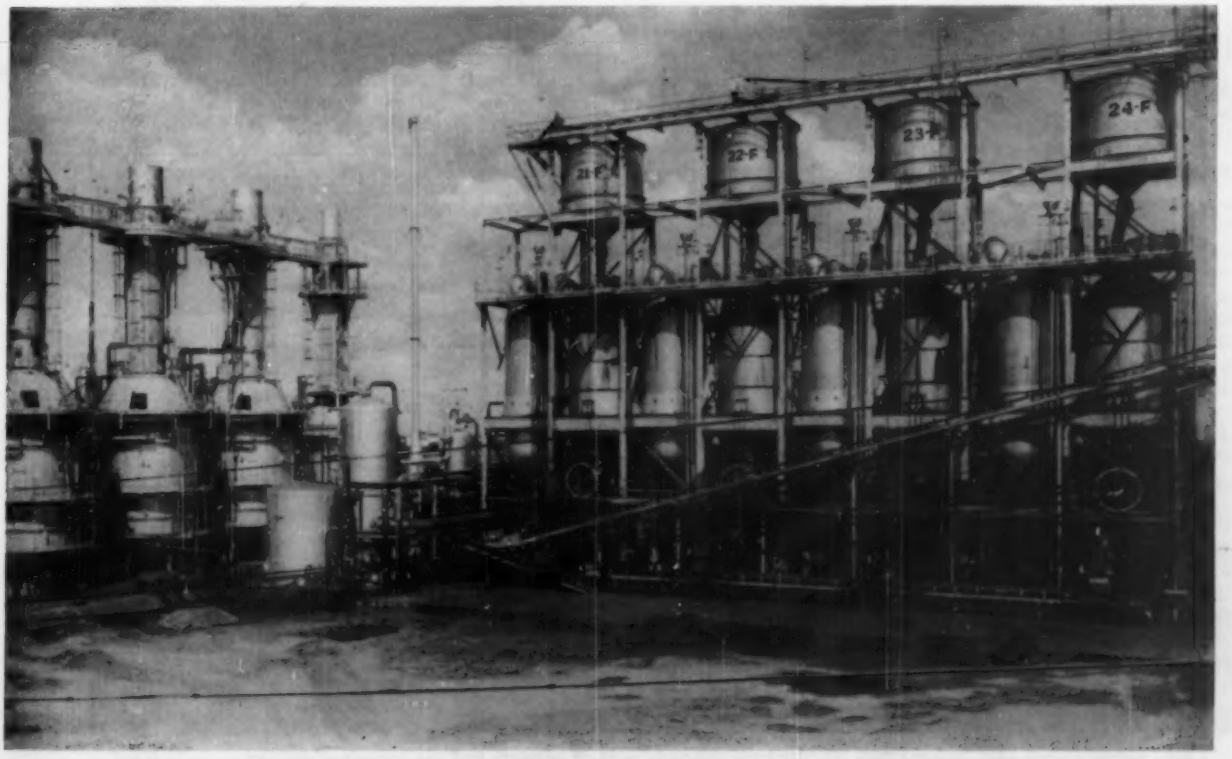


Table 1. Material and labor requirements for HyL sponge iron plants at Monterrey per metric ton of iron.

	Units	200 T/D Plant	500 T/D Plant
Natural Gas	SCF	25,000	18,000
Electric Energy	KWH	75	7
Water	M^3	9	4
Iron Ore (65% Fe.)	M. ton	1.6	1.6
Operating Labor*	M.H.	1	0.5

* *Excludes maintenance, overhead and ore handling outside battery limits.*

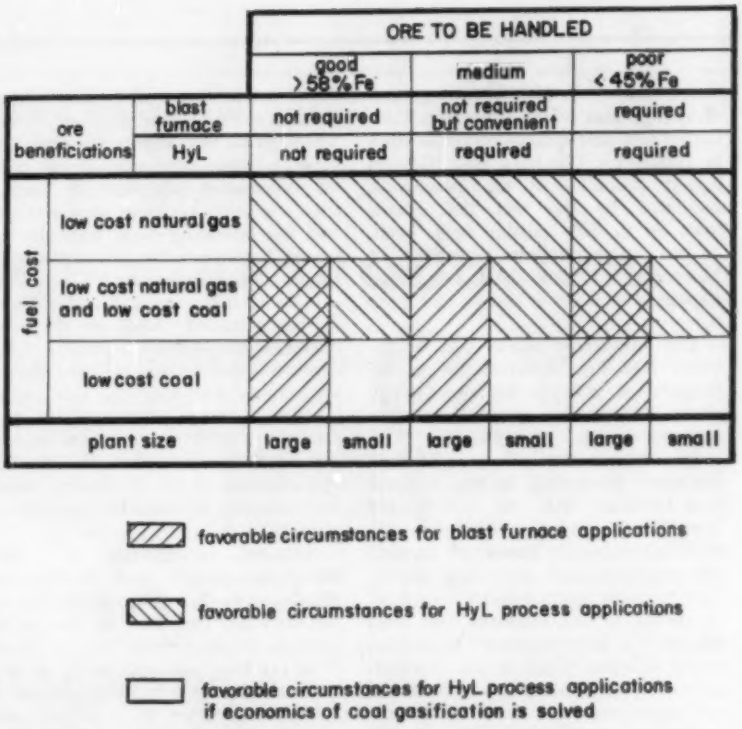


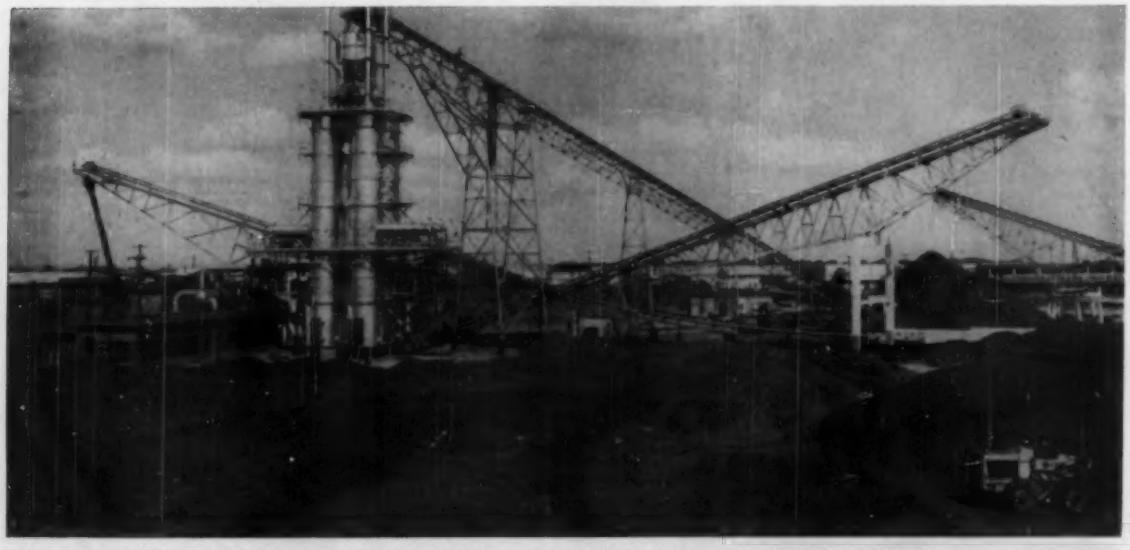
Figure 1. Comparative applications for the HyL and blast furnace processes.

200 ton/day sponge iron plant. This unit has been in operation since the latter part of 1957. It was designed to produce hot sponge iron to be used subsequently in the adjacent electric furnaces. The plant has two sections, gas producing area where the reducing gas is produced through the steam-methane reforming reaction, and the reduction area where the oxygen content of the ore is reduced to very low levels.

At the present time, due to a redesign of the reduction reactors and the addition of a reforming furnace formerly in operation in Hojalata y Lámina's pilot plant, the unit is actually producing over 250 metric ton/day. The plant, consisting of five identical reducing reactors can be operated on only four of them, maintaining almost full capacity, thus giving great flexibility for maintenance and repair work.

500 ton/day sponge iron plant. This unit has just gone into operation producing cool sponge iron. Although identical process principles have been used for the design of both sponge iron plants, the 500 ton/day unit has been designed with a greater degree of mechanization and higher heat conservation, thereby permitting more economical operation, as can be seen in Table 1 which gives material and labor requirements for both plants.

As was the case in the 200 ton/day, the gas producing section provides the necessary reducing gas so that the ore can be reduced and cooled in the reactor vessels. The economics of concentration and briquetting of the sponge iron is presently being investigated in some detail in an experimental unit incorporated into the operation of the new 500 ton/day plant. This unit, which has a production capacity of nearly 100 metric tons of



Fierro Esponja's ore yard and roasters. Pictured are the vertical shaft roasters and the conveying system.

briquettes per day, has been set up to study whether the expense of beneficiation and briquetting is made up by the credit gained during the melting of this lower gangue briquetted sponge iron.

Generally, sponge iron must be reduced in size to bring about effective separation between the iron and the gangue. The effectiveness depends on the manner in which the iron and the gangue appear. A fine grained intermixing structure will require a higher degree of size reduction than a coarse grained structure. Therefore, the size to which sponge iron will have to be crushed to effect a satisfactory elimination of gangue, will vary from one ore to another.

In the existing set-up, sponge iron fines from the 500 ton/day plant are separated from the coarse fraction, ground for silica liberation, upgraded, and briquetted in a ram type briquette press. Upgrading is accomplished by drum type dry magnetic concentrators where silica content is reduced to less than 3% in the final concentrate. This requires grinding the sponge iron down to 48-mesh. Experience indicates that impact mills perform better than any other type of mill for this particular application, because the latter cause the smearing of iron particles over the nonmagnetic silica grains thus interfering with the magnetic selection of the particles in the concentration stage.

Experimental pilot plant. An experimental pilot plant is being erected with special facilities for studying the effects of several parameters on the reduction cycle. The experimental set-up will allow investigation of basic process principles and production problems encountered in the large scale operation in Monterrey, or elsewhere, in a HyL unit. Study of the possibility of using different fuels to produce reducing gases for the process could be undertaken.

The plant, which will consist of one six-ton capacity reactor and its associated gas producing equipment, will also be able to process ores of different sources under controlled conditions in order to determine their reducibility and possibility of being sucessfully used in a HyL gaseous reduction unit.

Sponge iron melting

Sponge and sponge-scrap mixtures have been melted in electric arc-type furnaces varying in size from six to sixty-five tons of metal per charge. The complete range from 100% scrap to 100% sponge charges has been covered, with the greatest number of heats around the 50% level.

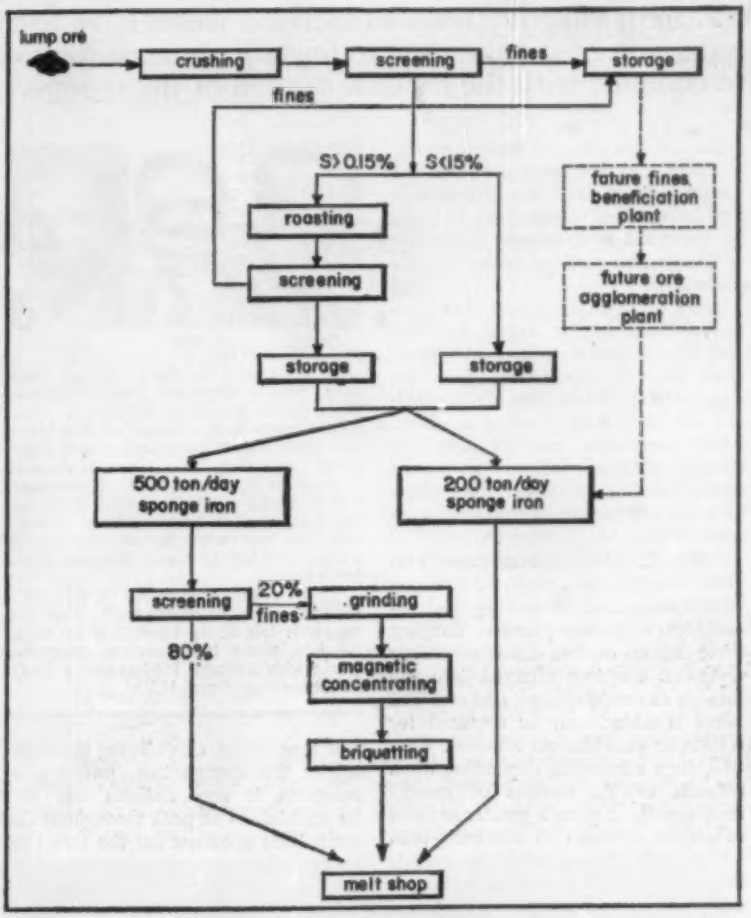


Figure 2. Flow sheet of Fierro Esponja works in Monterrey, Mexico, consisting of the ore preparation section, a 200- and a 500-ton/day sponge iron plant. An experimental pilot plant (not shown) is under construction.

Most of the melting has been done in the larger furnaces which have a refractory-lined 17-ft. diam. shell, dished bottom, swinging roof and electrode assembly, three 20-in. electrodes through the roof, electrodes positioned automatically and individually, taps at six different electrical potentials, positioners actuated by impedance sensing, access door on one side and a discharge trough on opposite side, and the whole assembly on a tilting axis centered between door and discharge trough.

The method of charging the furnace, currently in favor in the larger furnaces for heats of up to 70% sponge iron, consists in adding sponge iron around a central cone of scrap. In a typical heat for a 65-ton furnace, 8-10 tons of scrap are placed in a conical pile in the center of the furnace and, by means of a tilting bucket, 26-28 tons of sponge iron are added around the cone of scrap in such manner that the charge is slightly depressed at the center and that most of the vertical furnace walls are covered by sponge except for the section at and around the water-cooled access door.

Sponge iron is not as good an electrical or thermal conductor as scrap, and as a consequence, only that sponge which receives the arc or direct radiation is melted rapidly. With the above method of charge placement, electrode penetration is primarily in the scrap after the first few inches have been penetrated. The scrap pieces have the density of massive iron, above 7, whereas sponge has a particle density of about 3. Since the bulk density of scrap is lower than that of sponge, it follows that the interstitial voids in the scrap are much larger than those in the sponge. The larger voids permit more rapid run-down of molten metal away from electrodes into a pool on the furnace floor.

The central portion of the charge is melted until only a lining of unmelted sponge around the furnace wall re-

. . . most effective ways to increase yields have been to increase the extent of reduction of sponge iron, to lower gangue content of sponge, or to add carbon to combine with the residual oxygen of the sponge.

mains. At this point, a second bucket of 17-19 tons of sponge is added and the process repeated, the sponge melting being aided in the second charge by the good heat transfer properties of the molten pool of metal already present.

After most of the charge has been melted, acid slag is largely removed and lime is added to give a lime-to-silica ratio of about 2 to 3 in the residual slag. Simultaneously, the balance of 10-12 tons of scrap is added. After completely melting this last charge, refining follows a normal course, varying with sulphur and phosphorous contents of sponge-scrap mixtures.

Table 2 gives consumption and yield averages for a series of 21 melts which were made following the normal HyL melt shop practice. The first three items of the furnace charge represent the iron charged into the furnace as scrap, sponge, and ore. The latter is added only as required for carbon or phosphorous removal.

Sponge iron melts, depending upon residual oxygen content of sponge iron, usually require a greater amount of carbon addition to the bath than scrap melts. The residual oxygen is adjustable at will and could be almost completely eliminated in the sponge iron plant at the expense of a greater reaction time. Under Monterrey conditions, the best economic balance from ore to ingot corresponds to an oxygen elmination in the sponge iron plant of about 90%. Remaining oxygen is removed during melting by reaction with carbon to form carbon monoxide. Cold sponge iron has, as produced, around 1.5 to 2% carbon, and additional carbon may be added if required, either to the sponge iron or to the melt. It is important to note that CO evolution produces a bath boiling action which brings about a desired circulation of metal favorable to the development of uniform temperature throughout the bath and which accelerates refining reactions.

The electrical energy required to melt sponge iron is undoubtedly higher than that required to melt scrap due to the additional silica content. However, this increase is partially offset by the following facts: Sponge iron, having a higher bulk density than scrap, permits heavier single charges for a given size furnace, thereby diminishing the number of recharges, and thus decreasing heat



Celada Muller Riblett

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Earl W. Riblett is on M. W. Kellogg's engineering consultant staff. With the research lab at its formation in 1932, he has since held several executive posts with Kellogg. Riblett has a Ph.D. in Chemistry from N.Y.U.

and time losses; also, during the melting of the sponge iron, power consumption is very uniform and can be maintained at peak throughout the melt. This accounts for the fact that energy consumption proves to be only slightly higher for sponge iron than for scrap.

Table 2. Summary of consumption and yield averages, melting scrap-sponge charges at Hojalata y Lamina, S. A.

NUMBER OF HEATS		21
FURNACE CAPACITY	Metric Tons	65
SPONGE/SCRAP	%/%	63/37
FURNACE CHARGE		
Scrap (Fe eq.)	Kg/m ton	374
Sponge Iron (Fe eq.)	"	626
Oxides (Fe eq.)	"	5
Lime	"	68
Carbon	"	20
Manganese compounds	"	6
Fluospar	"	2
Patching cement	"	16
Other*	"	83
ELECTRIC ENERGY		
Charge to tap	kwhr/m ton	599
TIME		
Power on (net time)	minutes	226
Tap to tap (gross time)	"	295
Ingot metal yield	Kg/m ton	889
Final Carbon	%	0.10

* *Materials like gangue, residual oxygen, foreign materials, etc.*

Other test data indicate that ingot metal yields are improved when either or both slag-forming gangue and iron oxide content of slag is reduced. The most effective ways to increase yields have been to increase the extent of reduction of sponge iron, to lower gangue content of sponge, or to add carbon to combine with the residual oxygen of the sponge. Optimum results may be obtained at different levels depending upon ore characteristics, cost of gaseous fuels, and other local considerations.

In addition to Hojalata y Lámina, S.A. (HYLSA), sponge iron has also been melted in electric arc furnace by Aceros de México, S.A. (AMSA) following same general procedures above and with generally similar results.

Quality

A problem in the use of scrap that has become increasingly important in recent years is the growing contamination of melting stock by residual elements in carbon steel. Common elements encountered in the manufacture of iron and steel are C, Mn, P, Si, S, the contents of which can be controlled by proper charging and subsequent refining of the steel bath to meet the desired chemical and physical specifications. However, there are certain other elements usually present in steel, like Cu, Ni, V, Sn, etc., which can not be eliminated by common furnace practice. In general, these elements are undersirable in plain carbon steels, due to their deleterious effects on certain properties, such as surface, deep-drawing, or weldability.

Replacement of a portion of scrap by sponge iron in the electric furnace charge decreases the amount of residual elements in the steel. Iron ores normally used contribute little as residual elements. Sponge iron, being made directly from ore will yield a higher quality steel than that obtained from melting scrap. It has been found that sheet fabricated from sponge iron melts is an ideal material for deep drawing applications. Weldability of sponge iron sheet is also increased over that exhibited by scrap-made steel.

Improvement of the steel surface obtained with the use of sponge iron in the furnace charge, promotes a much better product quality in enameling and tinning operations, where surface quality is of utmost importance.

PHILIP G. COLIN AND JAMES GILLIN
Merck Sharp and Dohme

Organic pilot plant operations

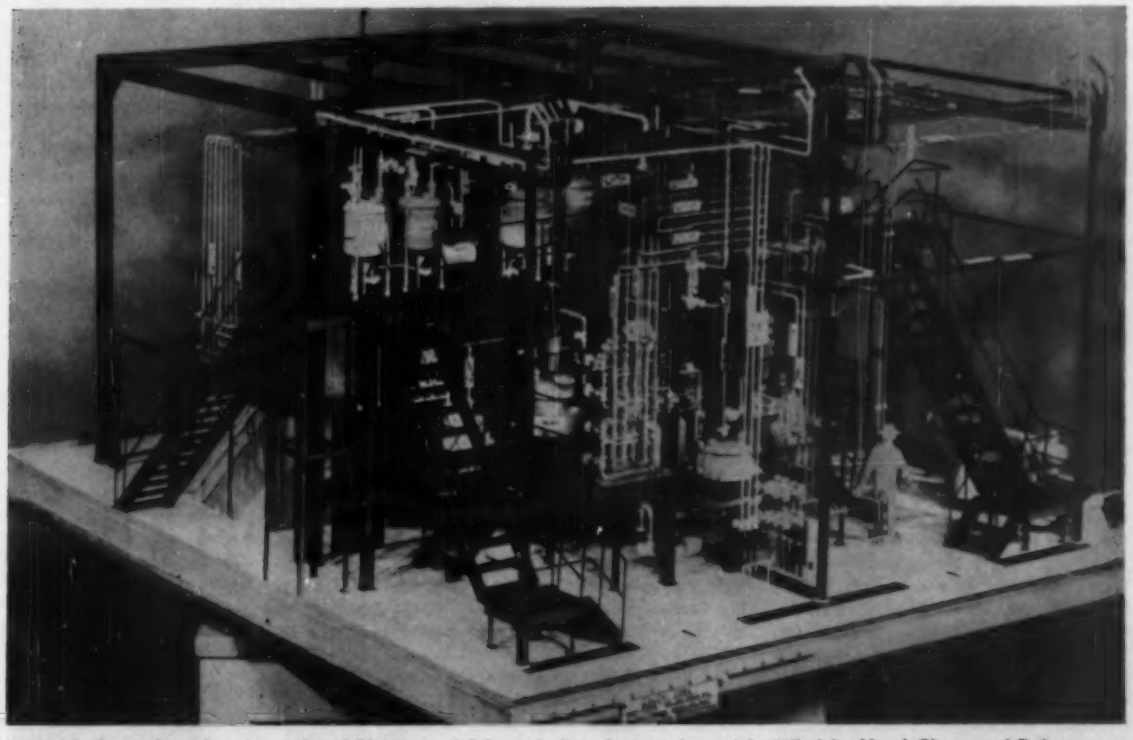
Versatile pilot plants provide valuable operating know-how in the dynamic fine chemical industry. Here are three typical cases—Claisen condensation, Grignard reaction, catalytic hydrogenation.

THE MANUFACTURER OF FINE CHEMICALS, along with other segments of the chemical industry, is faced with the problem of whether to pilot a new process at a level intermediate between bench scale and full manufacturing level or proceed directly with the installation of a macroplant based on laboratory information. Obviously, considerable time could be saved by elimination of the piloting phase, but the pitfalls are many and in our experience intermediate scale operation has been found to be the more economical approach because it precludes costly errors. Many times reactions that work well in one to five-liter flasks function poorly when expanded even 100-fold to a pilot plant level. Differences in surface to volume ratio, rates of heating and cooling, degrees of agitation, and rates of addition of reagents all may have a profound effect upon the yield and quality of product. Thus, the desire to provide the design engineer with a foolproof process militates against the elimination of the piloting stage.

In addition to establishing the validity of the process, there are at least two important dividends which result from piloting the process. First, thorough development of the operating procedures at the intermediate scale usually results in the production of sufficient material to explore the full potentialities of the new product in its field of application; and second, the pilot study provides operating know-how which is of inestimable value in starting the full-scale plant.

Ideal pilot plants

In a progressive research organization, the chemist is not limited in his choice of reaction or its operating conditions as long as he can show satisfactory yields, quality of end



Isometric front view of scale model of Claisen and Grignard pilot plant equipment installed by Merck Sharp and Dohme.

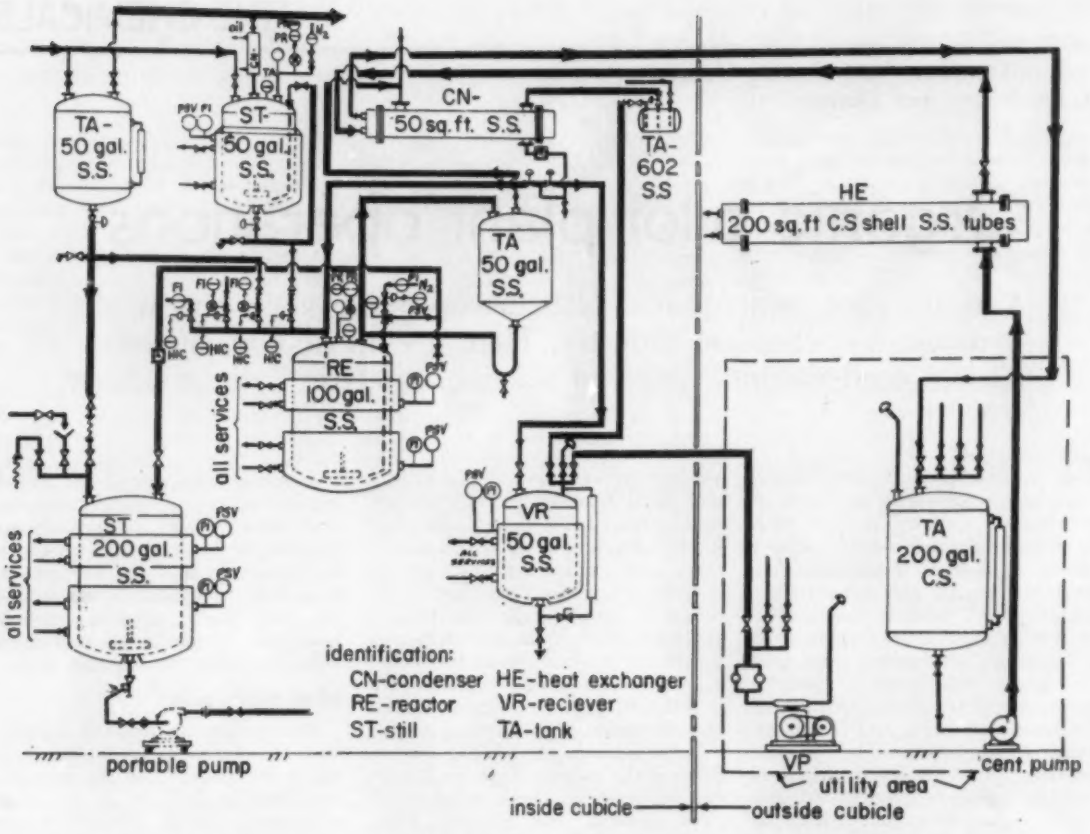


Figure 1. Flow sheet showing versatile pilot plant equipment to be installed for performing Claisen reactions.

product, and economy of manufacture. Therefore, an up-to-date pilot plant should have the facilities to run on very short notice any chemical reaction under any conditions that a chemist can run in the laboratory and obtain a reproducible yield and product quality. The gamut of reactions will involve gas, liquid, and solid phases; temperatures ranging from liquid nitrogen to flaming heat; and pressures from full vacuum to thousands of pounds per square inch.

Frequently, the process to be piloted will utilize such difficult chemicals as hydrogen cyanide, phosgene, hydrogen fluoride, ozone, and hydrogen sulfide; necessitating careful scrubbing of vent gases as well as maintaining a safe concentration of these reactants in the operating zones. Other reagents such as sodium, metal hydrides, and active catalysts may be hazardous from the standpoint of fires. Still others, particularly the volatile combustible solvents, can create explosive mixtures which can be ignited by static discharges. Thus, electrical equipment must be explosion proof.

The wide variety of reagents poses many problems of finding suitable materials of construction. Today, ordinary carbon steel is useful mainly in bringing the utilities to the chemical reactions; the equipment in which the reaction is run is constructed of glass-lined steel, stainless steel, silver, nickel, and Monel. Exotic materials such as Duriron, Durichlor, the Hastelloys and other alloys, tantalum, titanium, glass, porcelain, carbon, and plastics are utilized.

The scale of piloting is always important in any chemical process. Wherever possible it is desirable to pilot as near to the full-scale plant as possible. In the heavy chemical industry, it is usually necessary to extrapolate in the range 100 to 1000-fold, but fortunately in the fine chemical industry, where the volume of product required is smaller, extrapolation is about one magnitude less—namely 10 to 100-fold.

In general, the majority of the reactions in the fine chemical industry are of the batch type. Long holding times to complete reaction, low rates of addition of reagents, and low rates of heat and mass transfer preclude placing many reactions on a continuous basis. Also, the volume of product required dictates against installing continuous equipment. However, it is not uncommon to find combinations of batch and continuous reactions where they can be coupled effectively.

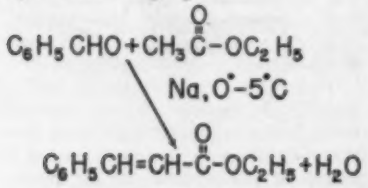
Continuous reactions find applications in less than 10% of the cases in this industry. Typical examples of continuous reactions are the oxidation of aldehyde collidine with nitric acid in the manufacture of nicotinic acid and the conversion of dextrose to arabonic acid by air oxidation in the liquid phase in the production of Vitamin B_2 (Riboflavin).

To exemplify the piloting of batch-type organic chemical reactions, three typical unit processes have been selected, namely (1) a Claisen Condensation, (2) a Grignard Reaction, and (3) a Catalytic Hydrogenation.

Claisen condensation

A Claisen condensation is typified

by the following equation:



In the fine chemicals industry a rather high percentage of processes employ this type of reaction. Piloting of this reaction presents the engineer with several unique problems.

The Claisen condensation procedure obtained from laboratory experiments used a sodium hydride emulsion in benzene. After completion of the condensation, the reaction mixture was charged to an aqueous solution of ammonium thiocyanate and hydrochloric acid. From this mixture, the desired intermediate separated on cooling and was isolated by filtration. This procedure had been run in 250-500 ml. laboratory flasks and it became necessary to operate a pilot plant within 24 hr. at a daily rate of at least 200 times this capacity.

The immediate task was to decide on an arrangement of available equipment. A 100-gal., glass-lined reactor with impeller-baffle type agitation and a flush-bottom valve was chosen for the hydride reaction. Since the unit was not directly connected to a second vessel where the thiocyanate reaction could be run, in the interest of time, it was decided to add sufficient water to the completed hydride reaction to decompose any residual sodium hydride. The batch was then to be dropped into a kettle containing the aqueous thiocyanate-acid solution and transferred to a still in another building for completion of the reaction. Eight runs were made by this technique with yields of only 60% of those obtained in the laboratory (despite the fact that these handling operations were duplicated in the laboratory with no adverse effects). The yield problem appeared to be resolved as Batch 7 and 8 were much closer to expected results, but in Batch 9 the unexpected happened. As in all prior runs, sufficient water was added to the 100-gal. vessel to decompose *all* the sodium hydride charged and after 20-min. aging the batch was dropped into the aqueous thiocyanate solution in the open kettle. When about one-quarter of the batch was dropped, a fire started in the kettle which was fed by benzene from the 100-gal. reactor. Fortunately, nobody was injured and the sprinkler system adequately minimized damage to the equipment and building.

The fire was believed to be caused by an unreacted piece of sodium hydride lodged in the annulus around the flush bottom valve. When the batch was dropped to the kettle, the fluid flow dislodged this piece and discharged it into the water in the open kettle causing the spark to ignite the benzene.

This reactor obviously could no longer be used. A 30-gal. 304-type stainless steel unit with no bottom outlet was available, but even using this there could be no assurance that all the hydride would decompose.

This new unit was redesigned and within two days the necessary changes were completed to permit safe operation. A retractable flow leg was added to the 30-gal. unit and was connected with flexible stainless steel tubing to an inlet nozzle on a new 50-gal. glass-lined still which had been installed. After quenching in the 30-gal. stainless steel unit and aging as before, the batch was blown into the thiocyanate solution in the 50-gal. glass-lined unit. All operations were conducted remotely and the batch was handled in an atmosphere of nitrogen. Not only was safety achieved, but satisfactory laboratory yields were immediately attained in this equipment.

This is an example of the need for versatile equipment. Our pilot plant at Rahway, N. J., is being renovated at this time and equipment will be installed similar to that shown in Figure 1 with more adequate feed tanks, rotameters, instruments, and remotely operated valves.

Other Claisen considerations

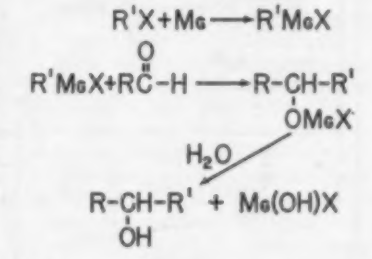
From the viewpoint of economy, a sodium sand is far cheaper to use than sodium hydride. The use of sodium sand was investigated in the process discussed earlier. The 30-gal. vessel was equipped with a scraper-type agitator and turbine on concentric shafts to obtain a good sodium dispersion. One of the added advantages of a sodium sand over sodium hydride is the elimination of the emulsifying oil, therefore toluene, sec-butyl-benzene, or a similar high boiling solvent can be used.

The sand is made by heating to above the melting point of the sodium, vigorously agitating to effect the dispersion, and then cooling to less than 80°C without agitation. If agitation is continued during cooling, the sand may re-agglomerate, causing severe agitation problems and loss of the sand. However, after cooling to below the melting point of the sodium without agitation, the mixture may then be agitated and an excellent sand results.

While there were many interesting aspects to the development of this particular Claisen reaction, one other point should be discussed. Moisture presents a serious problem to the control of any Claisen reaction. In pilot plant equipment, which is used for a variety of reactions, the customary procedure for drying is to boil out with acetone and then with ether until the Karl Fischer moisture determination on the ether boilout is no higher than that on the ether charged. This initially assures a dry still, but there is moisture in the solvent charged to the sodium hydride. In the particular case under discussion, it was found necessary to have the moisture content of the benzene at 0.2 mg./ml. ($\sim$ 0.02%) or less since any higher contents markedly affected the yield. Luckily this level is not too difficult to attain in solvent recovery systems, but before this maximum was established we were studying drying of recovered benzene with Molecular Sieves. It would seem simple to completely dry such a solvent merely by distilling a portion of it from a still as an azeotrope, leaving dry benzene behind. While this method works in laboratory equipment, it does not work well in a standard still. We have sampled the vapors above the liquid in such a system and found that the moisture is not carried out. Perhaps an inert gas sweep would help, but this is too costly. Thus, it is very important in this type of reaction to establish the precise limits of allowable water.

Grignard reaction

The Grignard reaction is another unit process which in some respects is similar to the Claisen reaction, yet in some ways very different and a distinct problem in itself. Most Grignard reactions are of the type:



The particular reaction discussed here is somewhat more interesting since the Grignard reagent is converted to dimethyl cadmium prior to coupling. Once again we were faced with a rush job and had to rely on the adaptability of our equipment to pilot the process. The dimethyl cad-

mium was to be prepared by adding methyl magnesium bromide to cadmium chloride.

$$2\,CH_3MgBr + CdCl_2 \rightarrow (CH_3)_2Cd + 2MgBrCl$$

The Grignard reagent could have been prepared from magnesium turnings and methyl bromide, but in the interest of time it was decided to avoid this well known step and to concentrate on the real development problems—the formation of the dimethyl cadmium and the coupling reaction. Grignard reagents are available commercially and the methyl magnesium bromide was purchased in 50-gal. drums. This brought up the first problem concerning how to charge the reagent in a safe fashion. The system decided upon is shown in Figure 2.

The shop prepared the necessary lines welded to bungs to fit the standard 50-gal. drums. The full drum was placed on a scale and the vent line and nitrogen line attached first. When the large bung was removed, a nitrogen sweep was started immediately. After five minutes purging, the charge line was inserted and connected to Still 608-A. Still 608-A had previously been dried using the procedure discussed earlier and was purged of air by applying vacuum and venting with nitrogen three times. Then 20 in. of vacuum was built up in St-608-A and 2 lb./sq. in. gauge nitrogen pressure put on the drum. The charge valves were opened and the requisite weight, plus eight pounds line holdup, removed from the drum. The valve at the still was closed, the nitrogen shut off, the drum vented, and the eight pounds of holdup drained back into the drum. All valves were closed and one pound of positive nitrogen pressure was left on the drum until the next batch. Twenty-three pilot batches were run in this fashion with no problems in handling the Grignard reagent. Changing drums caused no operational difficulties.

Ether was added to a thoroughly dried 100-gal. glass-lined still (St-608) located below St-608-A. Dry cadmium chloride was added through the man-head. The still was then closed and purged three times with vacuum and nitrogen.

Once again, as in the Claisen reactions, moisture is a problem. We established a Karl Fischer maximum of 0.1 mg./ml. H_2O for the ether and 0.5% for the $CdCl_2$. Another variable entered into this reaction, the physical condition of the cadmium chloride. Using Merck's milled, dried cadmium chloride, all results were satisfactory. Later, we started using unmilled, dried cadmium chloride from other sources; and the yields fell off drastically. After milling, each of these materials was found entirely satisfactory.

The dimethylcadmium was prepared by slowly dropping the Grignard reagent from Still 608-A into Still 608 with brine cooling on the latter still. The reaction is considerably exothermic, but easily controllable. After all the Grignard reageant was added, the mixture was refluxed at 85°C for two hours. After cooling, it was necessary to sample and assay the dimethyl-cadmium for completeness of reaction before proceeding with the coupling reaction. The assay was the standard Gilman test for unused Grignard reagent, but sampling was not a simple matter. The sampling method is shown in Figure 3.

The valve (I) was opened and a length of copper tubing inserted through the valve and sight glass into the still. Through this was passed a length of polyethylene tubing reaching into the batch. The external end of this tubing was attached to an evacuated bottle where the sample was collected.

Once the completeness of reaction was ascertained, the coupling was run without incident. The entire reaction mixture required a quench in aqueous hydrochloric acid. Two methods are available: dropping the batch slowly into acid-water, or adding the acid-water solution to the Grignard reactor. In the pilot plant, the latter method was used without difficulty. However, a rock-hard annular ring of inorganic salts was always found around the flush bottom outlet after discharge of the batch. This never caused any plugging problems. When this process was transmitted to the factory, the decision was made to reverse the method of decomposition to preclude water from entering the Grignard unit and thus save on drying operations. This same inorganic cake, without any water to dissolve part of it, plugged the outlet valve and became a problem to the production group.

New pilot plant facilities

Our renovated pilot plant at Rahway also includes a new Grignard unit with provisions for versatility and adaptability built in to handle and evaluate operating procedures such as

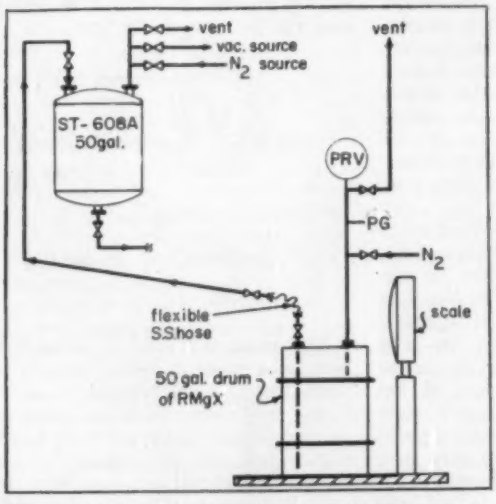


Figure 2. System used for charging Grignard reagent.

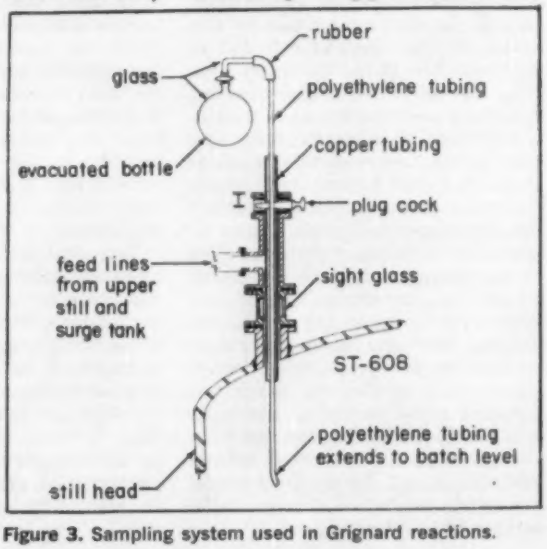


Figure 3. Sampling system used in Grignard reactions.

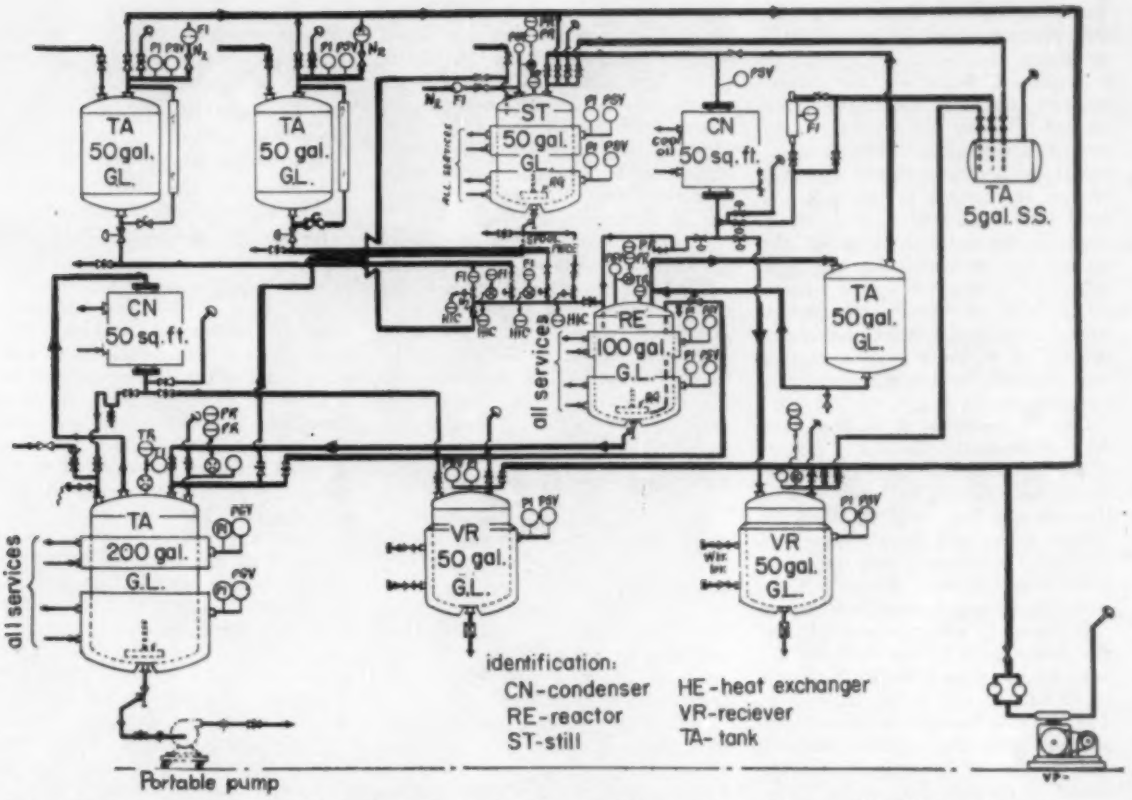


Figure 4. Flow sheet of new pilot plant unit for evaluating operating procedures for a variety of Grignard reactions.

the one just described. A flowsheet of the new unit is shown in Figure 4.

Both this Grignard unit and the Claisen shown earlier will be operated by remote control. An instantaneous thermocouple (in tantalum tip) will be provided for each vessel since in both these processes it is imperative to hold within narrow temperature limits. A means of measuring off gas volumes is provided to judge completeness of the reactions since in Claisen reactions hydrogen will be evolved and in some Grignards, methane will be evolved. The off-gases are run through mercury traps to permit proper purging of air from all equipment.

The question of whether to use steam and water in the still jackets rather than hot oil or some other heat transfer agent such as Dowtherm has been debated. It is our opinion that as long as the vessels are remotely operated, we have better control with steam and water. With the wide variety of operating conditions, there are many reactions that are touchy and alternate heating and cooling may be necessary. Dowtherm and hot oil systems do not lend themselves to rapid cooling.

Only one condition still causes us some concern. The best way to tell if a Grignard reaction is going properly is to observe it through a sight glass. Since it is almost invariably run at reflux, temperature is no indication. If a man must go in the cubicle to look at the reaction, why have a remotely operated set-up? Once the reaction starts, it is easy to keep it going and all further operations can be run remotely. Only a small amount of reactant should be necessary to start the Grignard reaction, thus minimizing the hazard. However, we propose to investigate periscopes and/or T.V. viewers to solve this problem.

Catalytic hydrogenations

The catalytic hydrogenations of interest are at relatively low pressures, with 2000-5000 lb./sq. in. gauge the top of the range, and most running less than 150 lb./sq. in. gauge. The catalysts are usually Raney nickel, or more recently the Girdler nickel catalysts and noble metal catalysts such as Palladium-on-Charcoal.

The catalytic hydrogenations from the chemists are invariably run in rocker-bombs under constant volume conditions. In almost all cases in the past few years—and this embraces at least 10 such processes—it has been found that not only the amount of catalyst but more often the pressure required could be reduced considerably in the transition to constant pressure hydrogenation in the pilot plant. While the amount of catalyst and the pressure required vary from process to process, in general the amount of catalyst can be reduced to one-third to one-fifth of that required in rocker-bombs. In general, when rocker-bomb pressures were in the range of 100-200 lb./sq. in. gauge, equally good results at about 50 lb./sq. in. were obtained in the pilot plant. This is indeed fortunate, for materials of construction compatible with the variety of processes handled are frequently limited to those offering excellent corrosion resistance. Our pilot plant equipment consists of three hydrogenators—a 5-gal. stainless steel unit good to 5000 lb./sq. in. gauge, a 50-gal. stainless unit good to 100 lb./sq. in. gauge, and a 50-gal. glass-lined unit good to 150 lb./sq. in. gauge. Intermediate range pressure equipment is under construction. An American fabricator has recently put on the market a tantalum lined reactor which should

open new doors for those faced with high pressure work under corrosive conditions.

In general, water wet (or damp) catalysts are used since the small amount of water introduced on the catalyst is negligible. Where it is essential to preclude water, the wet catalyst is charged to the still and dried by solvent washing and decantation in the unit. On occasion the catalyst has been added in a plastic bag which is dissolved by the solvent. To do this in open kettle equipment is inviting a flash fire. Azeotropic removal of moisture from a catalyst may markedly reduce the activity of the catalyst.

Once the catalyst is charged, and dried if necessary, the still is purged of air following the same procedures described earlier. The batch is then charged to the catalyst, the still purged again, and the nitrogen from the purge is replaced with hydrogen, with the agitation stopped. Once under hydrogen, a new leak rate is determined (a leak rate under hydrogen is run prior to any charging and must be less than 3 lb./sq. in. gauge in 15 min. at 100 lb./sq. in. gauge). The batch is brought to desired temperature with the agitator running, and the rate of hydrogenation determined by pressure drop on the hydrogen cylinders.

One interesting point, which now seems obvious, was proven on two recent hydrogenations. The 50-gal. stainless steel unit is a fully-baffled, turbine-agitated vessel, while the glass unit has the standard Pfaudler impeller-baffle combination. Both have variable speed agitators. In the cases in point, where material of construction was not critical, hydrogenations were run in both vessels. Similar hydrogenation rates were obtained in each vessel if the hydrogen was fed subsurface in the stainless unit and above the surface in the glass unit. Adding hydrogen above the surface in the stainless unit gave much slower rates. In the fully-baffled unit the liquid surface is essentially flat and only a small surface area is presented for absorption of hydrogen. However, in the impeller-baffle, glass-lined unit, at agitation speeds above 100 rev./min., considerable vortexing occurs which draws the hydrogen into the liquid and thus is similar in action to subsurface addition in the stainless unit. At agitation speeds below 90 rev./min., the glass-lined unit was inferior. Tests were not run with subsurface additions of hydrogen in the glass-lined unit.

Following completion of the hydrogenation, the unit is purged of hydrogen with nitrogen and the batch pumped or blown through a closed pressure filter, set with a reliable filter medium such as Ertel pads, to remove catalyst. The filter contents are washed with solvent and the washes added to the batch. The filter then is blown with nitrogen and finally flooded with water so that the catalyst can be discharged safely.

In some cases, it has been possible to reuse the catalyst several times without regeneration. Where Raney nickel is used, this is easily accomplished by allowing the catalyst to settle and remain in the still as the batch is blown. When such low density catalysts as Pd-on-Charcoal are used, we recycle them from the pressure filter.

Pilot plant operations summary

We have tried in the preceding discussion to present some of the problems and some of the solutions to piloting processes in the fine chemicals industry. We have attempted to show the need for adaptability and versatility of equipment and the ingenuity of the development chemists and chemical engineers.

Only a few of the many unit processes with which the pilot plant engineer is faced have been discussed. Each complete process often contains five or more unit process steps and some, such as steroids, involve as many as 20 to 40 steps.

Two questions which might well be asked concern how long do we pilot the process and what do we do with the product. The answers to both questions are interrelated. The product we produce is used for safety (toxicity) testing and field (clinical) trials. We continue to pilot the process with three objectives:

1. to develop the process and establish operating yields.
2. to supply material for field trials.
3. to obtain the operating know-how to start the full-scale plant.

In the case of establishing operating yields, we strive, and in most cases succeed, to attain the optimum yields reported by the laboratory chemists. Attainment of these yields is not necessarily coincident with completion of the development of the process. In some instances, we have been able to reach laboratory yields almost immediately while a great deal of effort needs to be expended to develop the process to one easily and reproducibly handled in full-scale production. However, it seems almost always true, that when the actual operation appears simple, the yields are the hardest to attain. This latter situation may be a result of something very subtle. A few years ago, for example, we had a very easy extraction, concentration, and crystallization to run at the end of a long process. Laboratory checks found the product in proper quantity in the solvent to be extracted. Indeed, even laboratory isolation of an aliquot of the pilot batch gave expected results. The solution to this problem lay in the plastic tubing used to transfer the extract into a concentration unit. The solvent was removing a plasticizer from the tubing, which, even in small amounts, completely upset the crystallization from the concentrated solvent. A simple solution, however it was not easy to discover.

Once we have reproducibly attained desired yields and have developed a good procedure, we transfer operations to the Production Division. If we are ready to market the product, we will go from the pilot plant directly to the full-scale plant. If further field testing is required, we will transmit the process to an interim production area of the factory. In either case, the pilot plant engineer is assigned to the break-in of the process in full-scale equipment. If the process has been piloted properly, there will be no problem on the break-in. Our record of transferring processes from the pilot plant to factory is excellent with expected yields being attained almost immediately in practically every case. We feel that this is the greatest value of a pilot plant in the fine chemicals industry—that expected yields can be obtained on start-up of production units.



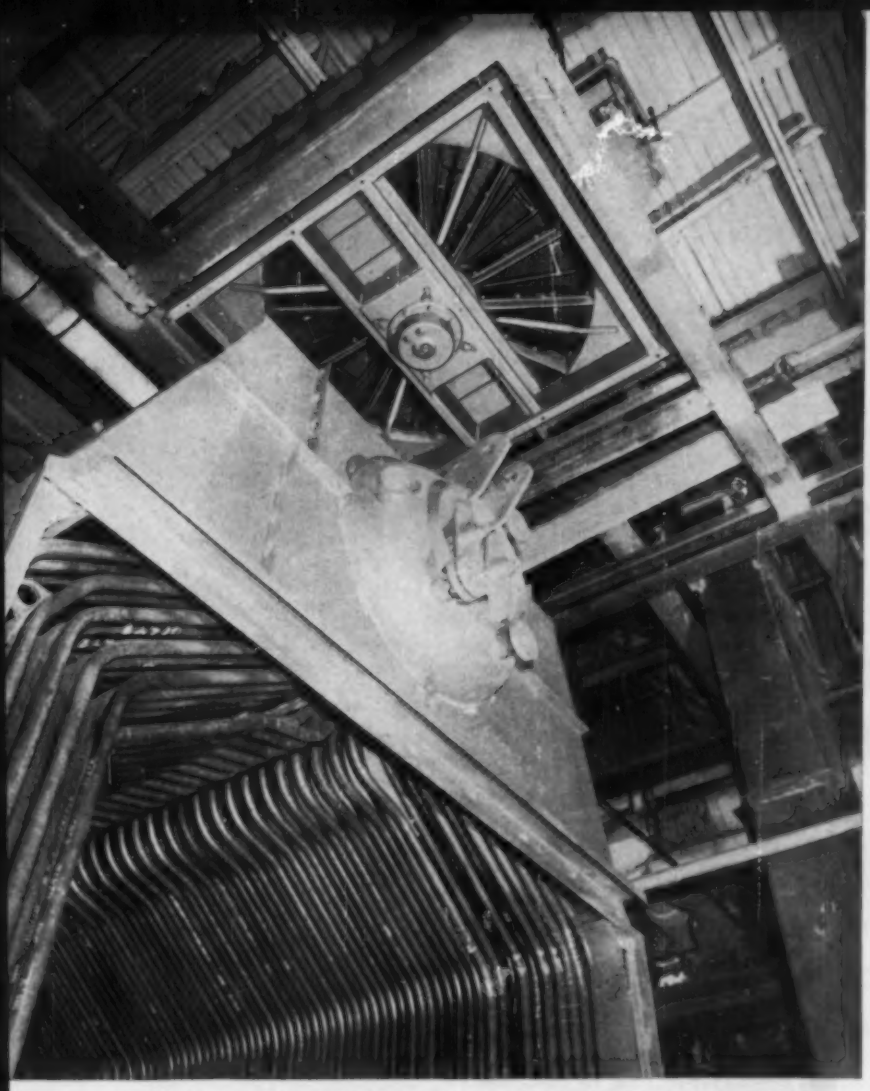
Colin



Gillin

Philip G. Colin is director of Merck's Rahway, N.J., pilot plant. His current work is on development of processes for synthetic fine organic chemicals, recovery of products manufactured by microbiological processes, and preparation of special inorganic compounds for the electronics industry. A registered patent agent, Colin received a B.S.Ch.E., B.S.E.E. and Ph.D. in Physical Chemistry from the U. of Washington.

James Gillin is manager of the Merck pilot plant. Joining the company in 1951, he has held the posts of senior chemical engineer and group leader in chemical engineering development. He received a B.Ch.E. and Ph.D. from Cornell.



The Ljungstrom Air Preheater at the B. F. Goodrich Company Shelton Plant is installed directly over the 65,000 lb/hr Wickes boiler. Flue gas leaving the boiler at 615°F passes through the circular rotor, which absorbs the heat and releases it into the incoming air. Preheated combustion air improves combustion, makes fuel burn cleanly. This Package Air Preheater was factory-assembled, and required only 100 manhours to install.

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COMPUTER PROGRAM abstracts

The Machine Computation Committee of the A.I.Ch.E. is interested in receiving program abstracts for publication as part of its program interchange activity. Details of this activity are given in the *Guide to Abstracts and Manuals for Computer Program Interchange*, which has just been revised based on experience during the first year the interchange has been functioning. Copies of the new *Guide* are avaliable at no cost from the A.I.Ch.E. in New York.

Once again the Committee wishes to emphasize the three rules for participation in the interchange program:

1) Abstracts submitted for publication must follow the form shown in the *Guide*.
2) The submitter of the abstract agrees to make available for publication a program manual, prepared as described in the *Guide*, should sufficient interest develop.
3) Abstracts for publication, and all questions concerning published abstracts, must be sent to the Machine Computation Committee c/o A.I.Ch.E.

Two manuals are now available: *Line Sizing* and *Liquid-Liquid Heat Exchanger Design*. The latter is described July p. 161. Scheduled for completion before the end of the year are manuals on *Multicomponent Distillation (Abstract 020), Nonlinear Estimation (016), Piping Flexibility (002), and Plate-to-Plate Distillation Procedure (017).*

Double-pipe heat exchanger calculation (059)

Analyst: J. J. Taborek, Phillips Petroleum Co., Bartlesville, Okla.
Programmer: A. H. Whitworth

Description: This is a multipurpose program, consisting essentially of two parts:

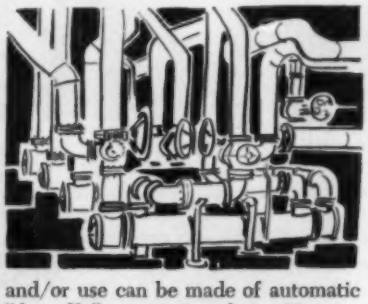
(1) For a given size of hairpin unit and specified maximum available pressure drop and/or flow velocity of both streams, it will establish the required number of units and their parallel-series arrangement.

(2) For given size and arrangement of units, it will solve all heat transfer and flow properties of the system if any two of the following parameters are unknown:

outlet temperature of hot fluid;
outlet temperature of cold fluid;
flow rate of hot fluid;
flow rate of cold fluid;
maximum fouling resistance.

The program handles liquids and gases without phase change and steam heaters. The inner element can be a single tube or multiple bundle, plain or longitudinally finned.

Provisions are made for streams of up to six components, the physical data can be supplied by data sheets



and/or use can be made of automatic "data file" containing about 60 components referred to by code numbers.

Computer: IBM 709 with 8 K and minimum 4 tapes or equivalent.
Program Language: 709 Fortran.
Running Time: 10 to 45 seconds.
Comments: Provisions are made for so-called "change cards" by which any of the input data can be changed for a subsequent run without re-copying the original case. Any number of problems can be run in succession.

The program includes optional "monitor" printout located at strategic places, used for trouble shooting and intermediate information. The monitors are classified according to importance, resulting in any desired degree of monitoring. Each will identify itself by a position number.

Availability: A program manual can be made available for publication should sufficient interest develop.

Solution of simultaneous linear equations (060)

D. J. Kaufman and C. W. Woo
Monsanto Chemical Company
St. Louis, Missouri

Description: The program will read in non-zero elements of the $n \times (n+1)$ matrix of coefficients and right hand sides for a set of simultaneous linear equations. These are solved by means of a Gauss reduction with error iteration and the answers are then printed out. It is possible to save the original matrix and merely read in changes to the original set of equations. Input and/or output may be on magnetic tape, if desired. On an 8K 704, up to fifty equations may be handled.
Computer: IBM 704 (8K).
Program Language: 704 Fortran II.
Running Time: Less than one minute for sets of up to fifty equations.
Availability: A program manual can be made available if sufficient interest develops.

WL DST1 (061)

Yonathan Bard
International Business Machines Corp.
Department of Mathematics and Applications
White Plains, New York

Description: The program solves distillation problems—both with given number of theoretical plates and unknown separation, and with given separation and unknown number of plates. Any number of feeds and side stream withdrawals may be specified. A wide choice of end conditions is available. The method of solution and list of specifications is given by Greenstadt et al, *Industrial and Engineering Chemistry 50*, 1644 (1958).
Computer: IBM 704, 8K core, 5 tapes, 1 drum.
Program Language: SAP.
Running Time: Roughly $PN^2/2$ seconds, where P is the number of plates and N the number of components (up to 24 allowed).

Continued on page 82



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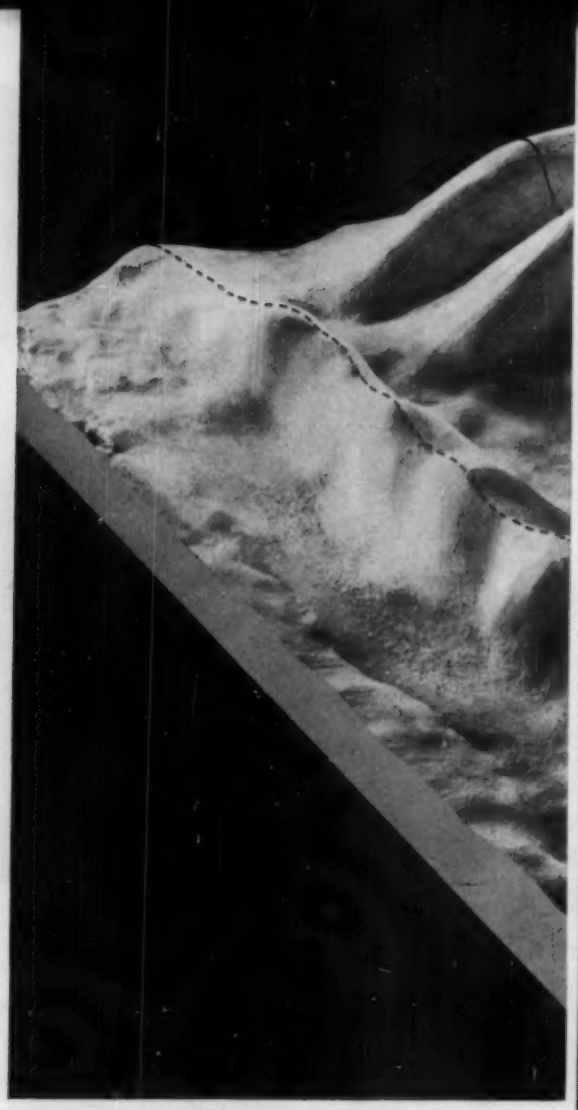
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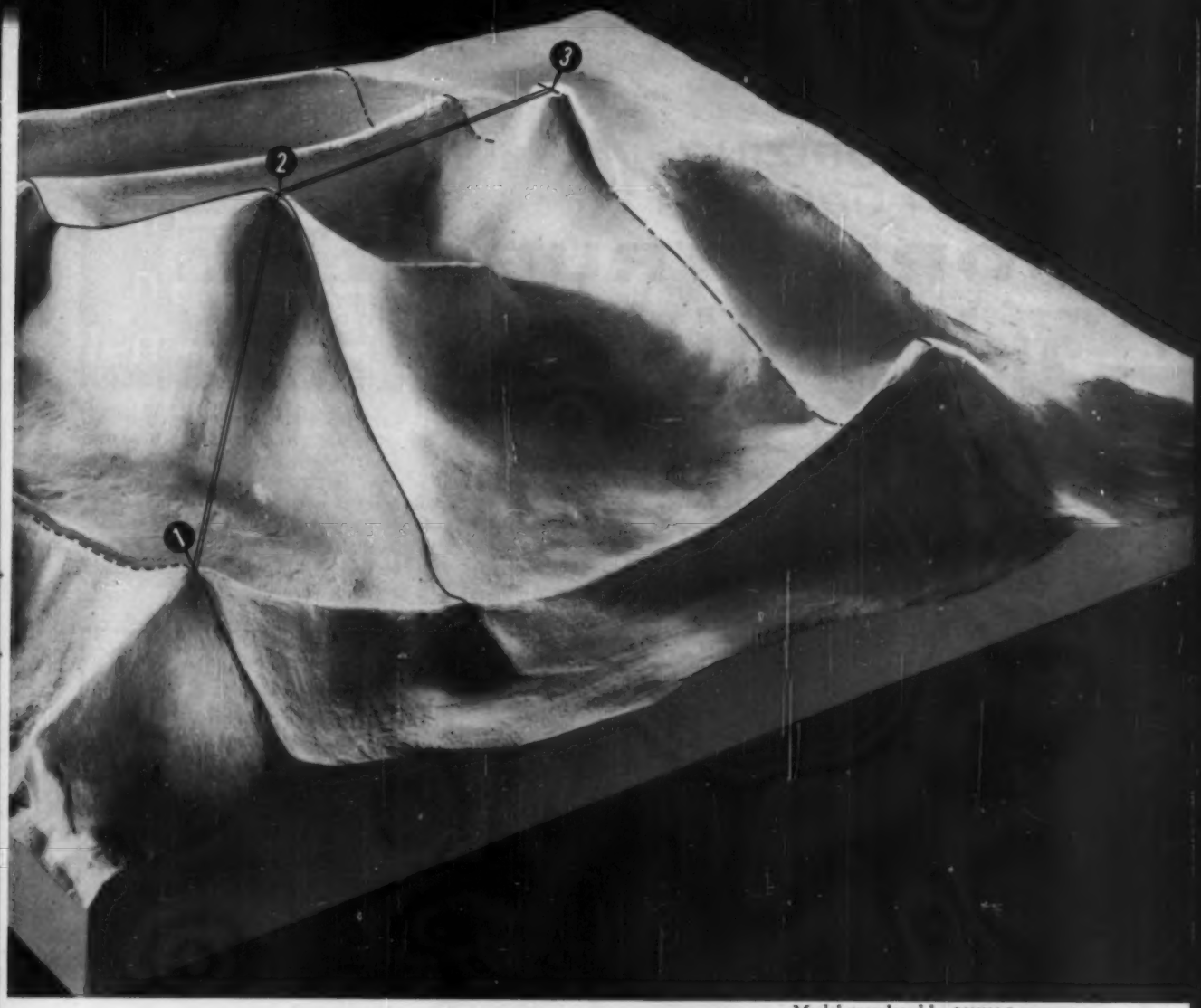


$\left(\frac{\delta a}{\delta t}\right)$ - - - - - - - This curve describes the design parameters for the entire process, with the maximum design factor occurring at point (1).

$\left(\frac{\delta b}{\delta t}\right)$ ——— This curve describes the profitability of the process. Note peak (2), where maximum profitability occurs.

$\left(\frac{\delta c}{\delta t}\right)$ - — - — - This curve shows the product quality variation. Maximum quality plateaus at point (3).

❶ ❷ ❸ ═══ Optimization for the entire process is achieved by operating along points (1), (2), (3).



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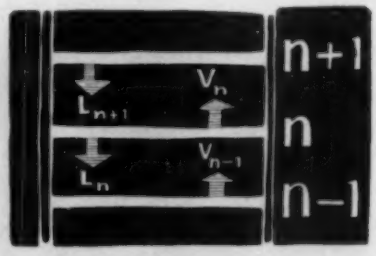


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Computer abstracts

from page 78



Comments: Many problems have been successfully run, but there still remain some (particularly of the absorber type) that cannot be done. The program is being revised to increase its range of applicability.

Availability: A program manual will be prepared if sufficient interest in the program develops.

Machine Computation Committee
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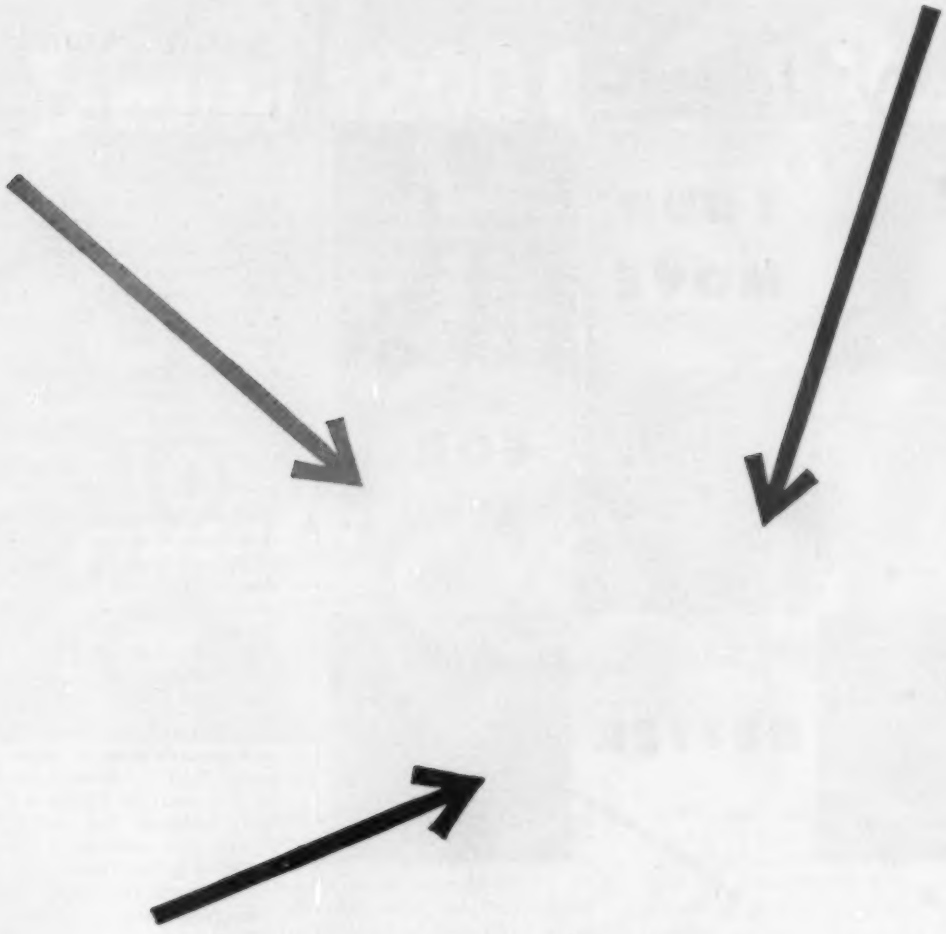
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How to know a good thing when you can't see it

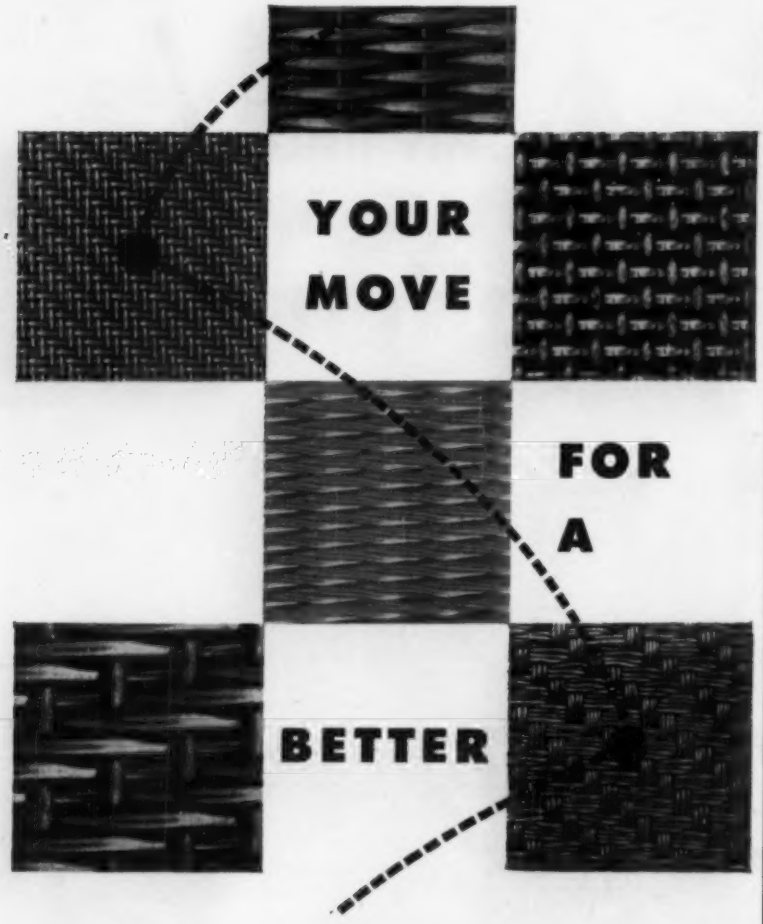
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industrial news

New west coast resin plant to be built by Colton Chemical (Air Reduction) will be devoted to resin polymerization. Colton's Flexbond copolymer emulsions and Vinac polyvinyl acetate resins will be produced at the City of Industry, California, site.

Expanding soda ash market will be further supplied by Food Machinery and Chemical Chlor-Alkali Division. Production boost of 200,000 tons a year at the Green River, Wyoming, plant will bring capacity to 750,000.

Synthetic resins, rosin size, and other rosin derivatives are to be produced at the new Hercules Powder plant in the Netherlands. The plant's annual production capacity will be about 30 million pounds. Slated for completion in the middle of 1961, the unit is located at Zwijndrecht, near Rotterdam.

A substantial expansion in facilities at Rayonier's research center at Whippany, N. J. is planned for the end of the year: a 10,000 sq. ft., two story addition. The consolidation of end-product research at Whippany is expected to free the company's Olympic Research Division at Shelton for more pioneering type work.

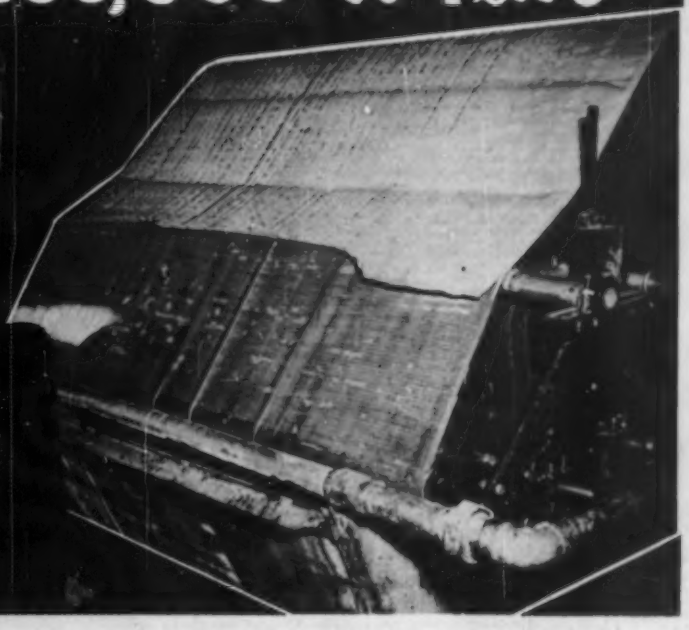
Operations have started at the new ammonium phosphate and wet process phosphoric acid plant of Valley Nitrogen Producers at Helm, California. Capacity is 75,000 tons a year of ammonium phosphate and complex fertilizers, and 16,500 tons of wet processs phosphoric acid. The plant-run acid Carlile Process is used.

A 70 percent nitric acid producing unit will be built by the French firm, Houilleres du Bassin de Lorraine. Located at Carling, Lorraine, the plant will be erected by S.B.A.

Twenty million gallons of cyclohexane a year is the capacity of the newly constructed Continental Oil Co. Hydrar unit at Ponco City, Oklahoma. UOP's process for conversion of benzene into cyclohexane will be used. Completion is slated for September.

Hydrofluoric acid has been added to the product list of Dixon Chemical with construction planned of a $3½ million plant on the company's Paulsboro, N. J. site. To be built next to the sulfuric acid plant, the unit will make about 11,000 tons of hydrofluoric a year.

Saves $200,000 a Year



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CONTINUOUS BELT
DRUM FILTER

A chemical processor was recovering gypsum by thickening followed by two stages of countercurrent washing on standard drum vacuum filters.

The filtration was not satisfactory. Excessive blinding of cloth filter media resulted in a daily loss of hundreds of pounds of valuable product.

When an EimcoBelt filter replaced the standard drum filter for the first filtration stage in this operation, it immediately overcame all blinding difficulties. Soluble losses were reduced to less than one-third of the average former loss experienced with the two conventional drum filters . . . resulting in savings of over $200,000 a year.

It soon became apparent that the EimcoBelt could handle the filtration load formerly handled by the two drum filters. Accordingly, the second stage drum was eliminated from the flow-sheet.

Freedom from blinding is one of several ways the new EimcoBelt filter is greatly extending the usefulness of vacuum filters.

EimcoBelt filter's unique new operating principle removes the filter medium from the drum every cycle, discharges the cake and washes the medium while it is away from the drum. A thoroughly cleaned medium is always returned to the drum.

Ask the Eimco representative in your area how EimcoBelt filters can cut costs in your operations. And write Eimco Filter Division for Bulletin F-2053.

THE EIMCO CORPORATION

FILTER DIVISION
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SALT LAKE CITY, UTAH — U.S.A.

RESEARCH AND DEVELOPMENT CENTER
201 SO. HICKS ROAD, PALATINE, ILLINOIS

B-564

For more information, turn to Data Service card, circle No. 75

How the bottleneck in packed tower Support Plates and Distributors

When towers were filled with the packings available a few years ago, a plate with a few holes was all that was needed to support the packing, and a few streams of liquid all that was needed to wet it.

Low in efficiency, low in capacity, low in flooding limits, the packing itself was the bottleneck to effective mass transfer.

But the bottleneck shifted from packings to support plates and distributors when high-efficiency, high-capacity packings, such as Intalox Saddles and Pall Rings, were developed. Higher flooding limits of the new packings were meaningless with the low flooding limits of the available support plates. Higher gas handling capacities of the new packings were stymied by the poor gas handling capacity of the support plate. The greater surface area and better internal distribution characteristics of the new packings could not be used to their maximum value because of poor initial distribution from the distributor plates available.

Our engineers went to work. Scale models of design after design were given preliminary tests in a four inch tower. Those that showed promise were made in a 30" size and subjected to test run after test run in our large experimental towers. Field experience in towers up to 10' in diameter was then evaluated against our test findings.

The "gas-injection" principle in support plates was one result of this intensive program. The "weir-flow" principle in distributor plates was another.

Today, U. S. Stoneware produces a wide range of support plates and distributors based on these principles which permit the engineer to utilize to the full the high performance characteristics of Intalox Saddles and Pall Rings in effecting mass transfer.

A few of these *are* illustrated and described briefly on these two pages. Full technical data is given in Engineering Manual TA-40 sent free on request.

FOR HIGHEST EFFICIENCY, HIGHEST CAPACITY COUPLE "U. S." TOWER PACKING WITH "U. S." TOWER ACCESSORIES

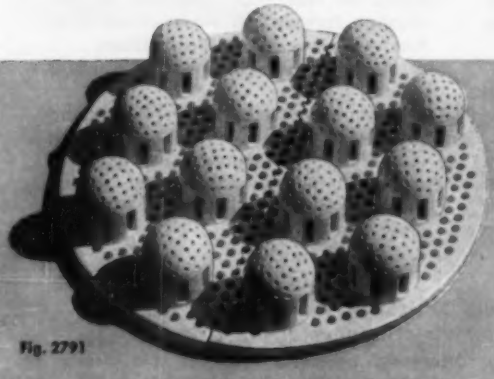


Fig. 2791

CERAMIC "GAS-INJECTION" SUPPORT PLATE
Slotted risers with perforated caps inject the gas into the tower. Liquid leaves the column through holes in the base plate. All plates through a size range from 12" through 60" have an effective working free area of better than 30%.

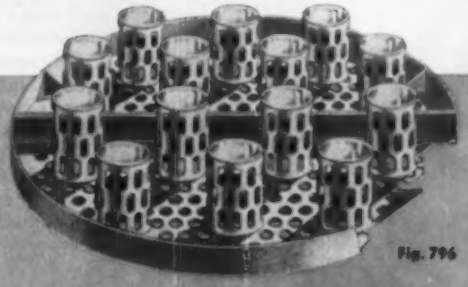


Fig. 796

METAL "GAS-INJECTION" SUPPORT PLATE
Similar in design to Fig. 2791; for towers from 4" dia. through 48"; percentage of free area generally exceeds 75%. Available in carbon steel, stainless steels, aluminum, copper, nickel, or any of the weldable alloys.

"WEIR-FLOW" CERAMIC DISTRIBUTOR
Cylindrical risers with "V" notches serve as downcomers for liquid, permitting greater flow as the head rises. The plate is supported on lugs which permit an annular space between distributor and tower wall through which gas rises. Ceramic "weir-flow" distributors are available for towers from 24" dia. through 96".

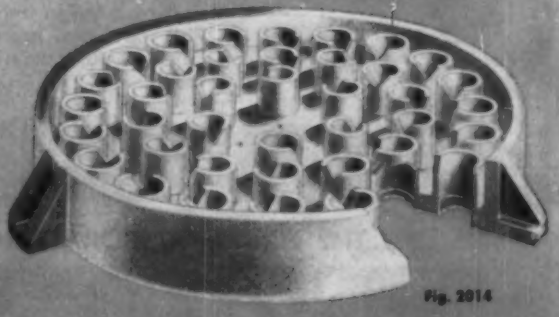


Fig. 2814

performance shifted to
AND WHAT WE HAVE DONE ABOUT IT!

"MULTI-BEAM" METAL SUPPORT PLATE
With a free area generally exceeding 85%, this "gas-injection" design principle is available in separate metal beams to fit towers up to ten feet or more in diameter. Number of sections vary from three to ten.

SPECIAL SUPPORT PLATES
Special support plates incorporating the "gas-injection" principle are available fabricated from impervious graphite, fiberglass reinforced polyester resin, or titanium.

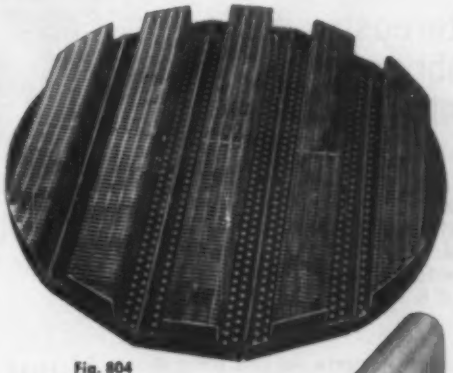


Fig. 804

METAL "WEIR-FLOW" DISTRIBUTORS
The basic "weir-flow" principle is shown here incorporated into a sectionalized metal distributor. Plates of this type can be made to fit towers of unlimited size. Metal "weir-flow" distributors are also available in one- or two-piece construction for towers up to 48" in diameter.



Fig. 798

"MULTI-BEAM" CERAMIC SUPPORT PLATE



Fig. 2808

For towers of 24" diameter up through 108". Made in the form of multiple beams for installation through manways. Has twice the load bearing capacity of Fig. 2791, even greater free area, yet retains all the advantages of the "gas-injection" principle.

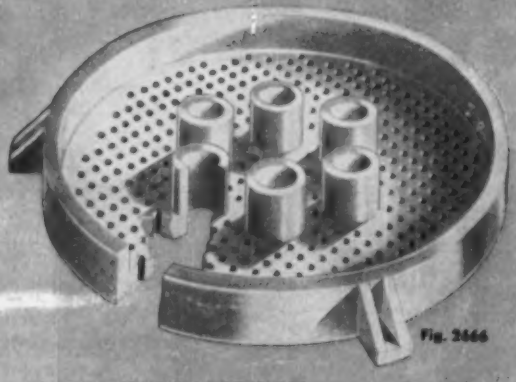
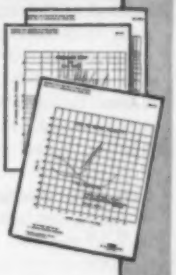


Fig. 2666

CERAMIC "ORIFICE" DISTRIBUTOR
This new distributor, on which patents are pending, is unique in that it offers the user a choice of three liquid rate ranges, enabling him to match his distributor to his flow requirements. For example, in a size to fit a 48" tower, Fig. 2666 is available for a liquid rate ranging from 12 to 50 gpm., or from 50 to 113 gpm., or from 113 to 414 gpm. This new distributor is made in chemical porcelain or in heat-shock resistant chemical stoneware in sizes to fit towers from 10" in dia. through 60".

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industrial news

Stereospecific rubber by improved process

Lowered investment and operating costs, elimination of discoloration and degradation are claimed for new technique developed by Crawford & Russell.



Pilot desolventizer unit in operation at Crawford & Russell Pilot Plant Center, Stamford, Conn.

A NOVEL PROCESS for producing stereospecific rubbers is expected to have an accelerating effect on commercial use of polyisoprene, polybutadiene, and ethylene-propylene copolymers. The method, based on an elastomer solvent system that bypasses the conventional crumb-type coagulation of emulsion processes, was originated by Crawford & Russell, Stamford, Conn. firm.

The process consists of a continuous high viscosity polymerization reactor, a desolventizer unit, a small dryer and a finishing line. The line is claimed to be much simpler than that of the standard synthetic rubber plant.

The continuous reactor produces polymer solutions with up to four times the rubber content of solutions produced in a conventional rubber reactor. The elastomer solvent mix contains 20% solids. In stripping the solvent, the desolventizer unit is operated at 200°F. It features a three minute cycle, and requires no shutdown for cleaning. The rubber sheet formed in the unit, according to company spokesmen, leaves the desolventizer carrying 10 to 15% water, as compared with 40% in crumb-type coagulation. Because the drying load is so much lower, the process utilizes a smaller, lower cost dryer than heretofore used in synthetic rubber plants. Complete specification drying of polyisoprene, for instance, is accomplished in 7-10 minutes at 180° to 200°F.

Another advantage claimed for the process is that it does not cause discoloration or degradation of heat-sensitive polymers. Also, exceptional production economies are said to be offered by lower operating costs and capital investment. Pilot plant production is now under way at Crawford & Russell's Stamford plant. #

Major industrial gas installation

New Air Products facilities at Creighton, Pa., will serve as central production, distribution center for the Allegheny region.

ANOTHER ADDITION to the country's industrial gas capacity is Air Products' new Allegheny plant. This latest major installation in the company's gas supply network produces 200 tons a day liquid oxygen and nitrogen, and 4,500,000 cubic feet per month of argon. It also has a monthly capacity of 3,000,000 cubic feet of helium and 4,500,000 cubic feet of hydrogen, available in tube trailers and cylinders. Medical gases and welding and cutting equipment are also distributed from the plant.

The $6 million facility is located in Creighton, Pa., near Pittsburgh, on a 22-acre site on the Allegheny River. Run by the company's Operating Department, it serves as a central production plant. Designed and built by Air Products, low temperature equipment for the unit, including the cold boxes, expanders, and storage tanks, was fabricated at the company's Allentown and Wilkes Barre plants. The facility consists of two generating units, liquid storage facilities for loading of tank trailers and gaseous charging systems for filling of tube trailers and cylinders.

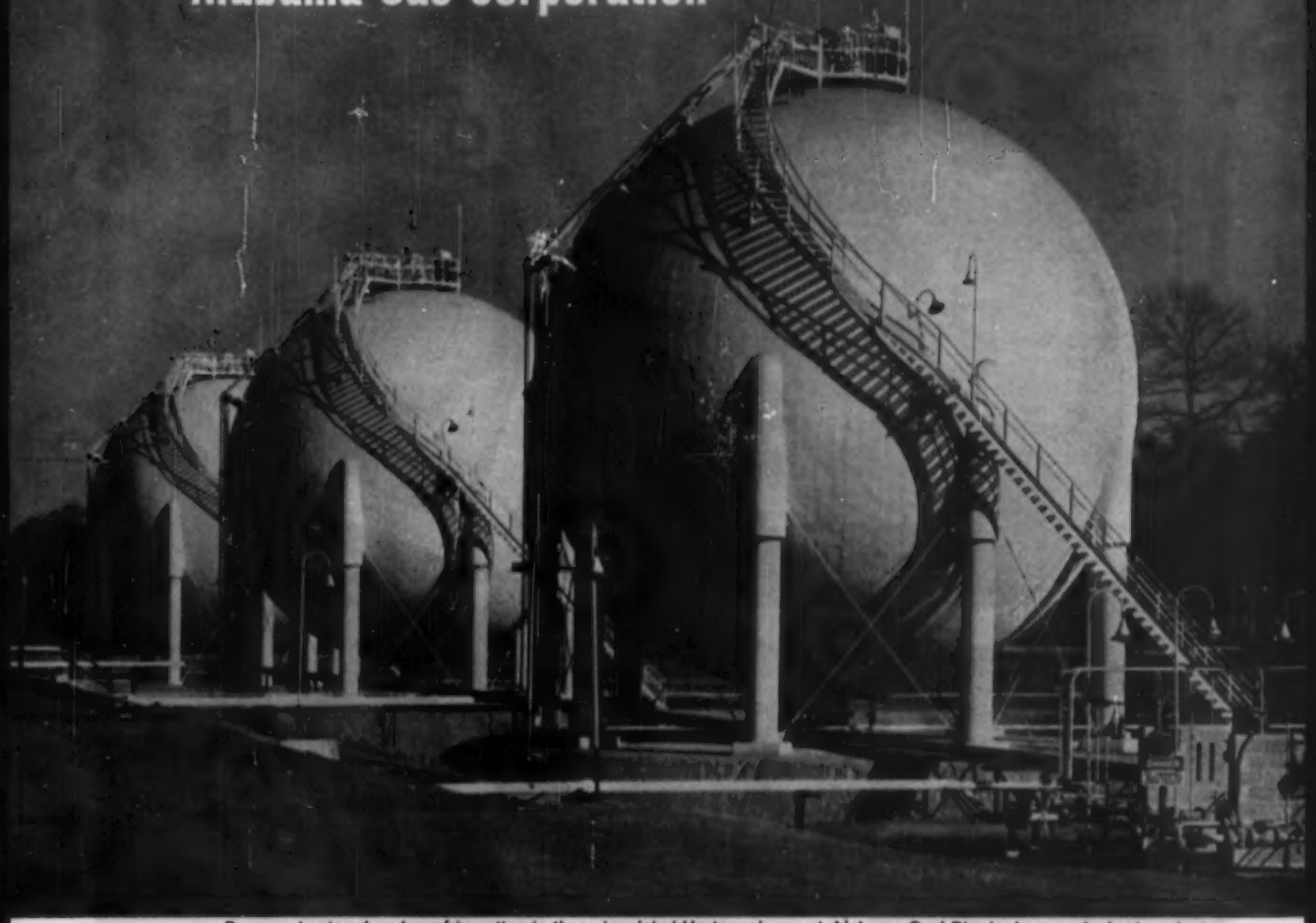
Aside from the additional gas capacity provided, the plant was located at the Allegheny site in order to provide supplemental oxygen for many of the Air Products on-site oxygen plants which serve major steel mills. The plant also serves a variety of other industries including the chemical. #



Overall view of Air Products' new Creighton, Pa., facilities.

HORTONSPHERES®

help "shave the peaks" for Alabama Gas Corporation



Propane is stored under refrigeration in these insulated Hortonspheres at Alabama Gas' Birmingham peak shaving plant.

Alabama Gas Corporation supplies the natural gas that feeds the furnaces of 49 growing communities. When cold weather strikes sunny Alabama, the demand for gas skyrockets. This situation calls for "peak shaving" . . . the boosting of normal gas supplies to meet a temporary condition.

Three CB&I-built Hortonspheres are the heart of Alabama Gas' peak shaving facility. These vessels store some 36,000 barrels of liquid propane at 30°F. to 35°F. During peak periods, the propane is vaporized and further processed to make it compatible with natural gas and is then introduced into the gas distribution system.

Hortonspheres are used extensively for the storage of volatile liquids and gases under pressure . . . with or without refrigeration. Write our nearest office for full details.

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COTTONSEED OIL HOSE
of neoprene tube and cover has been used for 5 years; no deterioration due to effects of oil or weathering.

SOLVENT HOSE
with a specially compounded neoprene tube unloads aromatic and other organic liquids — in service for 12 years.



ACID HOSE
with a tube of HYPALON in 93% sulfuric acid service on tank trucks; no acid damage in 2 years' service.

Long-term service similar to the above applications is available from hose made of Du Pont neoprene or HYPALON synthetic rubber. They handle oils and chemicals that ravage conventional rubber hose and also stand up to abrasion, aging, weather exposure and temperature extremes.

Hose which offers the long-term economy of Du Pont neoprene and HYPALON is available through your local rubber goods distributor. He can suggest which of the two synthetic rubber hoses best meets your particular requirements.

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Dutch chemical industry finds growth formula

Plants trebled, number of workers doubled since 1938. Wide variety of products accounts for 4% of world chemical exports.

SINCE THE END OF World War II, dollar turnover in the Dutch chemical industry has increased 45-fold, according to figures recently released by the Netherlands Trade Commission. From an annual production volume of some $36 million immediately following cessation of hostilities, total chemical production today stands at almost $1.2 billion. The Netherlands chemical industry ranks fifth in Europe and accounts for about 4% of the world's chemical export volume. Concurrently, from 1938 to 1959, the number of chemical plants rose from 200 to 600, and the number of chemical workers from 30,000 to 67,000. Invested capital in the chemical industry now amounts to approximately $625 million.

Coal-based chemicals

Largest single enterprise in Holland's chemical industry is the chemical plant complex of the Netherlands State Mines which currently has some 6,500 employees. Out of a total Dutch production of about 2 million tons per



Extraction equipment in a Dutch chemical plant.

year of nitrogen fertilizers, of which slightly more than 500,000 tons are exported, the State Mines' production of 900,000 tons puts it among the world's eight largest producers. Six types are made by State Mines—ammonium sulfate, calcium ammonium nitrate, calcium nitrate, phosphatic

continued on page 92

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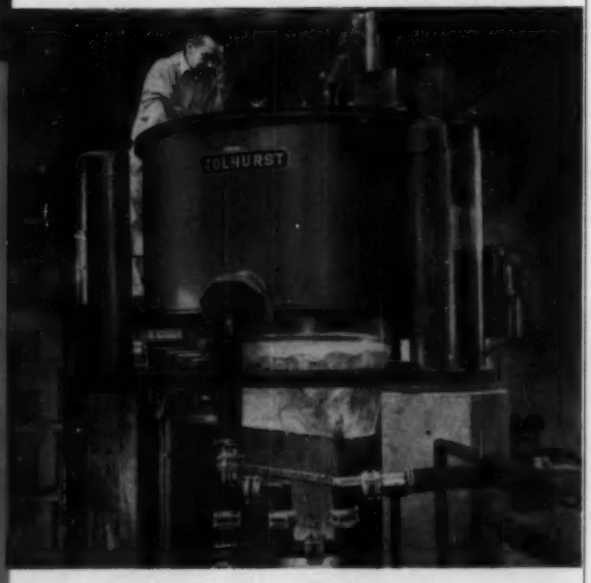
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BATCH-O-MATIC® assures constant quality control

The completely automated BATCH-O-MATIC reduces exposure time to maintain product stability. Variable speed and time controls duplicate any cycle of operations. Low-speed plowing helps prevent crystal damage. Can be constructed of stainless steel, "Hastelloy," titanium or other alloys. Corrosion-resistant coatings may be specified.

The BATCH-O-MATIC handles greater out-of-balance loads with minimum vibration because of its low, compact design and *exclusive* CENTER-SLUNG® suspension.

Fast bottom discharge increases production. For complete data, see the TOLHURST section in Chemical Engineering Catalog or write Dept. CEPT-960 for free bulletins.

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Dutch chemicals

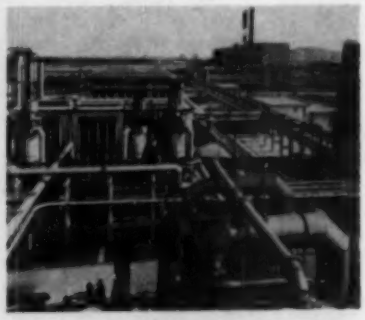
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ammonium nitrate, a compound N-P-K fertilizer, and urea.

Dutch coal is chiefly bituminous, rich in gas, with a low content of sulfur and phosphorous; coke made from it is particularly suitable for use in iron foundries, steel making, and the chemical industry. Coke-oven gas by-products such as pitch, naphthalene, and anthracene are exported to a number of countries including the United States.

Refining center

The Netherlands has become an important petroleum refining center for Western Europe, with a total refining capacity of 22.5 million tons of crude per year. Synthetic fibers and plastics are also one of the mainstays of the Dutch chemical industry; in 1959, the country exported about $24 million worth of plastics. Starting



Chemical facilities at coking plant of Netherlands State Mines.

with polyvinyl chloride in 1952, the Dutch have now branched out into epoxy resins, urea formaldehyde, phthalic anhydride, synthetic phenol, polyethylene, vinyl acetate, and unsaturated polyester resins.

Dutch salt reserves are enormous. This has led to development of large chemical facilities for production of caustic soda, chlorine, hydrochloric acid.

Six plants have a combined annual capacity of one million tons of superphosphate a year. In 1959, some 420,000 tons were exported, making Holland the second superphosphate exporting country of the world.

The paint industry has also undergone a spectacular development. Nineteen factories, employing some 2,000 workers, are engaged in the production of pigments alone, while 120 more plants turn out ready-mixed paints and printing inks. The Netherlands is the third largest paint exporter in the world.

Rounding out the picture are soaps and detergents ($45 million volume), perfume essences, cosmetics, pharmaceuticals.

Accounts receivable financing

How it works, where it fits into the chemical manufacturing industry.

THE VOLUME OF COMMERCIAL finance loans and factors' funds flowing into American industry is currently at the rate of about $15 billion a year, estimates T. H. Silbert, president of Standard Financial Corp. of New York. Of that sum, approximately $88 million is flowing into the chemical manufacturing industry.

Commercial finance loans and factors' funds are second only to bank financing in the chemical industry. In the main, the proportion of bank loans in the chemical industry is decreasing, while commercial finance loans are increasing. This, in Silbert's view, is a direct result of the Federal Reserve Board's tightening of bank credit during the last two years.

Many manufacturers could expand their sales volume if they could get sufficient seasonal lines of credit to carry peak inventories, pay peak labor, and finance peak receivables. With bank credit still rationed, the growing manufacturer's problem can, in some cases, be solved by turning to a commercial finance company, and raising the extra working capital by borrowing on his accounts receivable. This financing takes the form of a revolving fund secured by 30, 60, or 90-day trade receivables. Unlike other borrowing, accounts receivable financing is self liquidating. Advances against receivables are liquidated as the receivables are collected by the manufacturer.

A bank loan must be negotiated as to amount, and becomes due in a lump sum or in fixed installments; receivable financing, on the other hand, supplies funds in proportion to the volume of accounts assigned. This ordinarily coincides with seasonal peaks and valleys of the business, with more funds becoming available as sales increase, permitting the increase of inventories needed to fill orders.

Before and after

Table 1 is a case-history balance sheet of a manufacturer in the chemical industry—before and after his working capital was increased by ac-

continued on page 94

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Photo courtesy of Kind and Knox Gelatin Company, Camden, N. J.

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Niagara also offers these benefits: Fully automated where feasible. Complete removal of suspended solids. Minimum floor space requirements. Low initial and maintenance costs. See NIAGARA section in Chemical Engineering Catalog for details, or write Dept. CEPN-960 for bulletins.

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FEinc custom designs every filter for a specific application. This insures greater yield with less downtime over longer periods of continuous operation. Standard sizes range from 5 to 800 sq. ft. of filtering area.

The FEinc STRING DISCHARGE filter eliminates blow-back and produces a cake of low moisture content. The PRECOAT filter gives high clarity of effluent and flow rates. The HORIZONTAL filter offers extremely high hourly output. A complete line of SCRAPER, ROLLER DISCHARGE and DISC filters is also available. See complete data in the FEinc section in Chemical Engineering Catalog, or write Dept. CEPFE-960 for free bulletins.

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Accounts receivable

from page 93

counts receivable financing. Examination of the balance sheet, says Silbert, indicates that, as a result of commercial financing, this manufacturer improved his cash position by $50,000;

Table 1. Chemical company: before and after the accounts receivable loan.

	BEFORE	AFTER
ASSETS		
Cash	$ 0	$ 50,000
Accounts receivable	300,000	300,000
Inventory	225,000	225,000
Total Current Assets	$525,000	$575,000
Fixed assets (net)	280,000	280,000
Other assets	6,000	6,000
Total Assets	$811,000	$861,000
LIABILITIES		
Accounts receivable loan	$ 0	$240,000
Bank notes payable	190,000	0
Accounts payable	260,000	110,000
Accrued taxes	29,000	29,000
Accrued payroll	10,000	10,000
Accrued insurance	3,000	3,000
Secured loan current	0	50,000
Total Current Liabilities	$492,000	$442,000
Long term debt: Fixed asset loan	0	100,000
Total Liabilities	$492,000	$542,000
CAPITAL		
Total capital	400,000	400,000
Total Liabilities & Capital	$892,000	$942,000
WORKING CAPITAL		
Current assets	$525,000	$575,000
Current liabilities	492,000	442,000
Working Capital	$ 33,000	$133,000
CURRENT RATIO:	1.04-to-1	1.30-to-1

his working capital increased four times, and his current ratio went from 1.04:1 to 1.30:1. The company cleaned up its short-term bank loan, wiped out almost half of its payables, and was in a position to take cash discounts on future bills—without taking in partners or selling stock. The commercial finance company made available $240,000 in accounts receivable financing, and $150,000 in a fixed assets loan. Both together totaled $390,000, which permitted this company to expand sales and profits.

The upshot of having an extra $100,000 in working capital was about $500,000 in additional sales. For the financing to do this—that is, for the $390,000 financing—the manufacturer

paid about $12,000 in yearly charges—and earned approximately $50,000 in additional profits *before taxes* on the $500,000 additional sales.

Accounts receivable financing may be long-term or short-term. Merely by continuing to pledge new receivables and liquidating them, a manufacturer may make such financing as permanent as he wishes. The revolving line of credit fluctuates with sales. As shipments increase, cash advances increase, and the revolving fund is used over and over again. Merely by stopping the flow of new receivables, this method of financing can be terminated quickly whenever other methods of raising sufficient capital are available and advantageous.

This type of financing, warns Silbert, is designed only for prosperous companies whose working capital cannot keep up with the demands of expanding production and sales. No major commercial finance company, he emphasizes, would invest its cash in a company unless it considers that the funds can benefit the client company and stimulate its growth.

Comparative rates

Commercial finance rates are higher than bank rates—but, according to Silbert, the *dollar cost* is not necessarily higher. In borrowing from a bank on a 90-day or 180-day note, the borrower must maintain a 20% compensating balance in the bank, and accumulate funds for repayment during the period the loan is outstanding—meanwhile paying interest on the total amount of the loan for the 90 or 180 days. In commercial finance, however, if the borrower needs the cash for only 20 days of each month, for example, while he waits for his receivables to come in, the interest charged is only for 20 days.

Engineering grad demand still high

ChE graduates show sharply increased percentage of job commitments—results of an EJC survey.

JOB COMMITMENTS for graduating chemical engineers hit a three-year high in 1960, according to results of a survey just completed by the Engineering Manpower Commission of Engineers Joint Council. From a figure of 46% in 1958, the number of chemical engineering graduates having definite jobs lined up by May 20

continued on page 98

FEON®

specialists in LIQUID SOLIDS separation

GENERIC NAME, DEFINITION AND TRADE NAMES OF MAN-MADE FIBERS

GENERIC NAME	FTC DEFINITION	TRADE NAME
Acetate	—a manufactured fiber in which the fiber-forming substance is cellulose acetate. Where not less than 92% of the hydroxyl groups are acetylated, the term triacetate may be used as a generic description of the fiber.	ACELE™ CELANESE® ESTRON™ Also made and sold under generic name by 4, 5, 6, 8, 11 & 35
Acrylic	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of acrylonitrile units (-CH_2-$\underset{CN}{CH}$-).	ACRILAN® CRESLAN® ORLON™ ZEFRAN™
Azlon	—a manufactured fiber in which the fiber-forming substance is composed of any regenerated naturally occurring proteins.	No current commercial domestic production
Glass	—a manufactured fiber in which the fiber-forming substance is glass.	FIBERGLAS® Also made and sold under generic name by 10, 22 & 27
Metallic	—a manufactured fiber composed of metal, plastic-coated metal, metal-coated plastic, or a core completely covered by metal.	FILDOR™ LUREX™ METLON™ RAYMET™
Modacrylic	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of less than 85% but at least 35% by weight of acrylonitrile units (-CH_2-$\underset{CN}{CH}$-).	DYNEL™ VEREL™
Nylon	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polyamide having recurring amide groups (-$\overset{O}{\overset{\|}{C}}$-NH-) as an integral part of the polymer chain.	Made and sold under generic name by 3, 4, 6, 12 & 21
Nytril	—a manufactured fiber containing at least 85% of a long chain polymer of vinylidene dinitrile (-CH_2-$C(CN)_2$-) where the vinylidene dinitrile constant is no less than every other unit in the polymer chain.	DARVAN™
Olefin	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of ethylene, propylene, or other olefin units.	AVISCOPE® REEVON™ ROYALENE™ WYNENE™ Also made and sold under generic name by 30
Polyester	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of an ester of a dihydric alcohol and terephthalic acid (p-HOOC - C_6H_4 - COOH).	DACRON™ KODEL™ TERON™ VYCRON™
Rayon	—a manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which substituents have replaced not more than 15% of the hydrogens of the hydroxyl groups.	BEMBERG® CORDURA™ CORVAL® FORTISAN® TYREX Also made and sold under generic name by 4, 5, 7, 21, 25 & 29
Rubber	—a manufactured fiber in which the fiber-forming substance is comprised of natural or synthetic rubber.	
Saran	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 80% by weight of vinylidene chloride units (-CH_2-CCl_2-).	Made and sold under generic name by 11, 16, 18 & 24
Spandex	—a manufactured fiber in which the fiber-forming substance is a long chain synthetic polymer comprised of at least 85% of a segmented polyurethane.	LYCRA™ VYRENE™
Vinal	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 50% by weight of vinyl alcohol units (-CH_2-CHOH-), and in which the total of the vinyl alcohol units and any one or more of the various acetal units is at least 85% by weight of the fiber.	Limited production by 1
Vinyon	—a manufactured fiber in which the fiber-forming substance is any long chain synthetic polymer composed of at least 85% by weight of vinyl chloride units (-CH_2-CHCl-).	Made and sold under generic name by 5 & 31

1 du Pont de Nemours & Co., Inc.
2 Allied Chemical Corp.
3 American Enka Co.
4 American Cyanamid Co.
5 American Viscose Corp.
6 Avisun Mills, Inc.
7 Beaunit Corp., of Canada
8 Chemstrand Corp.
9 Courtaulds (Canada) Ltd.
10 Fabrilon Co.
11 Dow Chemical Co.
12 E. I. du Pont de Nemours & Co., Inc.
13 Eastman Chemical Products, Inc.
14 Firth Corp.
15 Fiber Industries, Inc.
16 Firestone Plastics Co.
17 Freudenberg Vlies-Chemie
18 General Tire & Rubber Co.
19 H. P. Smith Chemical Co.
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29 Reynolds Metals Co.
30 Shawinigan Resins Corp.
31 Stein Carbide Chemicals Co.
32 U. S. Rubber Co.

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Free reprints of this chart sent upon request

For more information, turn to Data Service card, circle No. 15



CORBLIN Diaphragm Compressors enable Southern Oxygen Co. to prevent product waste and contamination

Oxygen, argon and nitrogen manufactured by the Southern Oxygen Co. are moved in liquid form throughout the country by tank truck. To ensure simple, economical handling of the gas at distribution points, without the danger of contamination, Aminco supplied Corblin diaphragm-type compressors to this company for:

1. VAPOR RECOVERY: At distribution points where liquified atmospheric gases must be stored for long periods of time due to small or intermittent demand, large volumes of gas were previously lost through evaporation (1% of volume in 24 hours, vented to atmosphere through relief valves in the storage vessels).

Corblin compressors are now used to recover this gas and pump it in an uncontaminated state into cylinders.

2. TRANSFER OF LIQUIFIED GAS: Liquid from the tank trucks is transferred via Corblin compressors into storage vessels without the need for liquid pumps. Residual vapors are first pumped from storage vessels into tank trucks to pressurize the liquid therein and force it into the storage tank. After transfer of all liquid from the trucks, the valves may be reversed to suck vapor back into the storage vessel.

3. CONTAMINATION-FREE HANDLING: Gas is compressed by hydraulically-pulsed metal diaphragms which act as a barrier between gas and hydraulic fluid, and as a gasket to prevent leakage from the compressor. Thus, the gas does not come into contact with lubricants or other contaminating agents, and is delivered at a purity level of 99.9998%.

CORBLIN A REAL MONEY SAVER!

According to R. L. Swope, Chief Engineer of Southern Oxygen, Corblin Compressors actually pay for themselves in a relatively short period of time through dollars saved in reclaiming formerly-unrecoverable gas, and in the reduction of mileage on company tank trucks.

SEND FOR BULLETIN 4071—"5"

Aminco will forward on request this Bulletin describing Corblin diaphragm-type pumps and compressors. Units are available for all types of gases including highly toxic, corrosive and radioactive gas, at pressures to 30,000 p.s.i., and capacities to several hundred s.c.f.m. under certain conditions of operation. Units are also available for pumping all types of liquids.

AMINCO

AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Md.

AMINCO

Photo: Courtesy Southern Oxygen Co. shows Corblin Compressor installed in St. Petersburg, Fla. plant. Liquid argon storage tank in background.

Exclusive distributor of Corblin Pumps and Compressors in North America

For more information, turn to Data Service card, circle No. 74

what's your best estimate?

. . . a quiz for Chemical Executives who want to keep posted

QUESTION 1. In the petrochemical industry, price trends have not been uniform in recent years. Many major products have remained stable in price, some have gone up, quite a few have gone down. Do you know what the trend was for the following products from 1957 (third quarter) to 1959 (third quarter)?

	UP	DOWN	STABLE
AMMONIA	☐	☐	☐
BUTADIENE	☐	☐	☐
CARBON TETRACHLORIDE	☐	☐	☐
ETHYLENE OXIDE	☐	☐	☐
ISOPROPANOL	☐	☐	☐
STYRENE	☐	☐	☐

QUESTION 2. Since World War II, The Lummus Company has designed, engineered and/or constructed plants to produce many of the major petrochemicals. For which of the products listed above has Lummus done work?

AMMONIA ☐ BUTADIENE ☐ CARBON TETRACHLORIDE ☐
ETHYLENE OXIDE ☐ ISOPROPANOL ☐ STYRENE ☐

ANSWERS 1. *Ammonia and Ethylene Oxide remained relatively stable in price over the interval mentioned. Carbon Tetrachloride and Isopropanol prices went up; Butadiene and Styrene prices dropped. (Data from Petroleum Refiner—January, 1960).*

2. *All of them . . . as well as dozens of other chemicals and petrochemicals. Since 1915, Lummus has designed, engineered and constructed over 200 chemical and petrochemical installations throughout the world. Consider Lummus when planning your next project.*

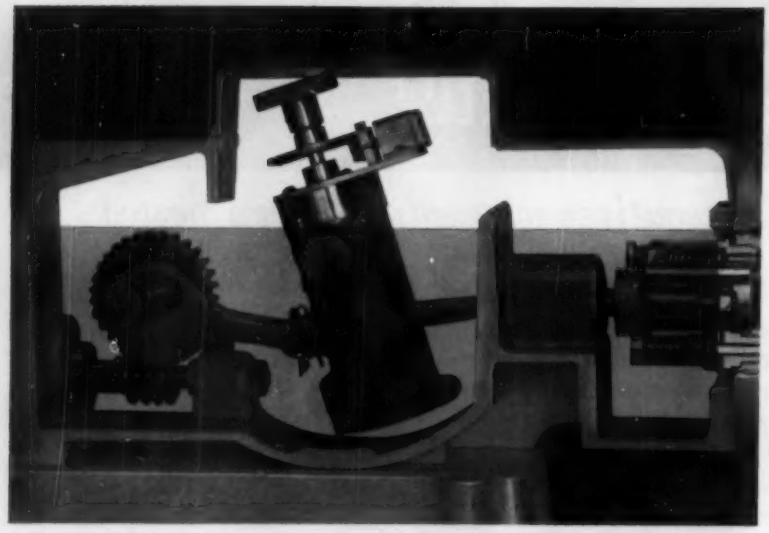
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This is why you never heard of a PULSAFEEDER wearing out!

Every moving part of every Lapp Pulsafeeder Metering Pump is completely submerged in oil. This total lubrication reduces friction to practically the theoretical minimum. And there's no possibility of corrosion from exposure to atmosphere.

For year after year of *extra* service life, Lapp Pulsafeeders continue to give you the exclusive advantages for which you bought them. Advantages like complete freedom from leakage and contamination; precision metering, at flow rates from a few drops to 15.7 gallons per minute; pressures up to 7000 psig; choice of heads for safe handling of acids, abrasive slurries, radioactive fluids; manual or instrument controls, We've got a new catalog to help you fit the right model to your process.



Lapp

***WRITE** for Catalog 59. Lapp Insulator Co., Inc., Process Equipment Division, 1209 Poplar Street, LeRoy, N. Y.*

For more information, turn to Data Service card, circle No. 78

Engineering grads

from page 95

has climbed sharply to 61% in 1960. Percentages for graduates in the other three major curricula—civil, electrical, and mechanical—dropped drastically from 1959 levels, although the figures for the electricals and the mechanicals are still slightly higher than for the chemicals.

"The high demand level for engineering graduates is apparently continuing," conclude the EJC survey analysts. The deduction is based on the fact that almost 82% of the prospective June engineering graduates (from accredited institutions) had completed definite post-graduate plans by May 20. This compares with 83% in 1959 and 78% in 1958.

By a wide margin, chemical engineers have, over the last three years, had the highest percentage entering graduate school; in 1960 the figure was about 14% compared to an overall average of 10% for all the engineering disciplines.

The corresponding 1959 survey reported a slight decrease in the number of graduates (all curricula) entering military service. This trend continued into 1960, and now represents a drop of 1.4% over the three-year interval (9.4%–8.4%–8.0%).

The EJC survey was based on a sampling equivalent to 39% of the 1959 engineering class. #

Polyethylene foam will be produced at new facilities at the Dow Chemical Hanging Rock plant, Ironton, Ohio. The addition, scheduled for completion about the middle of 1961, is located next to polystyrene facilities at the plant. Raw materials will be supplied by the company's Texas Division at Freeport.

A second major company in France to acquire the Scientific Design maleic anhydride process is Reichhold Beckacite. The French affiliate of Reichhold Chemicals will build a ten and one-half million pound a year maleic anhydride plant at Niort, Deux-Severs.

Texaco's new cumene plant went on stream recently at Westville, N.J. The 70 million pounds a year capacity unit, it is felt, will help meet the increasing demand for synthetic phenol.

Another entry into the perchlorethylene market is Hooker. A new production unit now being installed at the company's chlor-alkali plant, Tacoma, Wash., will supply Northwestern markets.

MAKING NEW AMMONIA PLANTS



STILL BETTER INVESTMENTS

Recent developments by The M. W. Kellogg Company in steam reforming make the production of ammonia by this process more efficient, more economical to install and operate, and more adaptable to individual conditions than ever before.

IN GAS PREPARATION, Kellogg now can design a plant for any combination of waste heat recovery suitable to the situation, and can achieve heat balance in the plant if desired. High pressure and low pressure feed can be used as economics dictate. Feedstocks can include naphtha as well as natural and refinery gas.

IN GAS PURIFICATION, Kellogg now can offer the optimum combination of methods to accomplish each step, including MEA and hot carbonate to remove CO_2, and copper liquor and methanation to remove CO.

Throughout the entire installation—from furnaces to synthesis converters—Kellogg's improved steam reforming process offers today's ultimate in low-cost, high-yield ammonia plants.

Among the many ammonia plants engineered and/or erected by Kellogg throughout the world since 1944 is the 300 T/D installation for Solar Nitrogen Chemicals, Inc. at Lima, Ohio, shown above. M. W. Kellogg is now designing and will erect a second plant for Solar—at Joplin, Mo.

For detailed engineering and economic data on Kellogg's steam reforming process, write for new booklet.

THE M. W. KELLOGG COMPANY

711 Third Ave., New York 17. *A subsidiary of Pullman Incorporated*

Offices of other Kellogg companies are in
Toronto, London, Paris,
Rio de Janeiro, Caracas, Buenos Aires

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S AND IDEAS FROM BOWEN ENGINEERING, INC.

y drying NEWS

BOWEN

RECOGNIZED LEADER IN SPRAY DRYING SINCE 1926

VOLUME 2, NO. 5

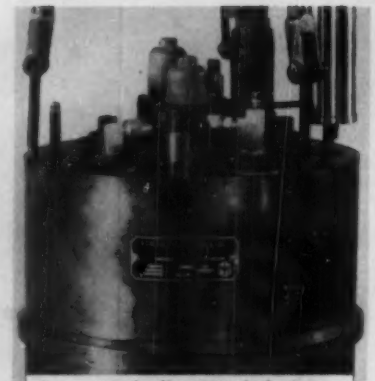
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Compact and self-contained, the Bowen Centrifugal Spray Machine can be taken out of service—for wheel changes, inspection, etc.—and be back in production within minutes.



mounted on the short, rugged main drive shaft of the motor to assure positive, efficient operation. A frequency converter set (which may be safely located out of hot, dusty and otherwise hazardous process areas) furnishes the high frequency current needed for machine operation. Frequencies can be precisely selected to provide any desired atomizer wheel speed between 4,000 rpm and 20,000 rpm.

MINIMUM ATTENTION REQUIRED—Automatic control of a constant feed rate is easily accomplished since feed introduction depends on simple gravity flow or easily-maintained low pressures. There are no pump-pressure fluctuations to cause operating headaches. This—coupled with the steady, unwavering speed of the high-frequency motor driven centrifugal wheel—guarantees day-in and day-out production of uniform product with minimum operator attention. And unlike centrifugal machines employing standard-speed motors, the Bowen machine has no complicated high-speed belt or gear system that invariably introduces complex, time-consuming problems of balancing, alignment, shaft distortion and excessive wear. The simple Bowen direct-drive design avoids these troublesome, production-halting problems and eliminates the need for frequent machine maintenance and repair.

For more information on the Bowen Spray Machine, request Bulletin No. 51.

SPEAKING FOR BOWEN



DONALD W. BELCHER, Bowen V. P. in charge of Engineering, *discusses three methods of atomization used in various Bowen spray dryer designs.*

ATOMIZATION TECHNIQUES

Atomization is the heart of the spray drying process. It is the means by which high liquid surface-to-mass ratios are attained for achieving the extremely rapid rates of evaporation essential to an efficient spray drying operation. Three methods are commonly employed:

PRESSURE NOZZLE ATOMIZATION—*Here, atomization energy is provided by fluid pressure. Liquid feed material is introduced to the spray dryer under high pressures through specially-designed nozzles. This method is restricted to solutions and uniform, fine-particle slurries. To a limited degree, variations in product characteristics may be obtained by changing nozzle designs and operating pressures.*

CENTRIFUGAL ATOMIZATION—*This method utilizes the energy of centrifugal force to atomize the feed material. Any solution or slurry that can be pumped can be handled by this method. A rapidly spinning wheel accelerates the feed into a thin sheet that leaves the wheel edge at speeds ranging from 150 to 450 mph. The tearing impact of the feed against the drying air atomizes both low and high viscosity materials into a fog-like mist. The centrifugal technique and its advantages are described further in the adjoining article.*

PNEUMATIC NOZZLE ATOMIZATION—*Sometimes called two-fluid nozzle atomization, this method obtains its energy for feed atomization from the pressure of a second fluid, usually air or steam. It is particularly well suited for handling abrasive feeds provided the nozzle is properly designed. Generally, this method is limited to low production capacity operations.*

Check items desired, clip and mail with your name, title and company address to Bowen Engineering, Inc., North Branch 13, N. J.

- ☐ Bowen Spray Machine Bulletin No. 51
- ☐ Bowen Test Laboratory Booklet

Information on the feasibility of spray drying:

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Anodes, carbon (p. 7). Info from G Lakes Carbon on production and search facilities for anodes. **Circle**

Blowdown Mutes (p. 153). Capaci from 1,500 to 500,000 cu. ft./m air and gas, 3,000 to 1,000,000 lb./ steam. Info from Pulsation Contr **Circle 22-1.**

Burst Discs, graphite (p. 149). Bu ratings from 1 to 200 lb./sq. in. Technical data and price sched from Kearney Industries, Delani Graphite Div. **Circle 1.**

Centrifugals (p. 92). Bulletins fr Tolhurst Div. of American Machine & Metals gives complete engineering d on the "Batch-O-Matic." **Circle 12**

Centrifugals, continuous, solid-bowl 133). Info from Bird Machine on co parative dryness of solids, clarity filtrates, capacity, cost per ton. **Cir 118.**

Centrifuge, pressure (p. 24). Bulle 1287 from Sharples gives details of P-400 Vertical "Super-D-Canter." **Cir 71.**

Compressors, air (p. 130-131). Bulle 94 from Cooper-Bessemer gives co plete details of new DMR line. **Cir 25.**

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DE to advertised products and services

MATERIALS

Alcohols, industrial (p. 137-138). Data from U. S. Industrial Chemicals on new government tax regulations. **Circle 150-1.**

Coatings, protective (p. 8). Technical data from Carboline on "Carbo-Zinc 11," all-weather maintenance coating. **Circle 105.**

Coatings, protective, high-temperature (p. 142). Data from Midland Industrial Finishes on "Sicon" coatings—up to 1,000°F in black or aluminum, to 550-600°F in decorative colors. **Circle 65.**

Defoamers, silicone (p. 140). Free samples and Manual on Foam Control offered by Dow Corning. **Circle 26.**

Desiccants (p. 111). Data from Johns-Manville on "Micro-Cel" synthetic calcium silicates. Used as fillers to absorb liquids, prevent, caking, control viscosity, extend pigments. **Circle 29.**

Fibers, synthetic (p. 95). Chart from FEON Div. of American Machine and Metals lists generic name, definition, trade names of man-made fibers. **Circle 15.**

Fluorides (p. 109). Data from Harshaw Chemical on wide range of fluorine compounds. **Circle 39.**

continued on page 102

SERVICES

Automobile Control (p. 121). Data from General Motors Research laboratories on new methods of automobile vehicle control. **Circle 27.**

Design and Construction (p. 12-13). Technical details from Badger on new 100,000 bpsd refinery built for Esso Nederland in Rotterdam. **Circle 21.**

Design and Construction (p. 127). Data from Werkpoor (Netherlands) on plants for ammonia synthesis, nitric acid, nitrolimestone, nitrophosphate, calcium nitrate, ammonium sulfate, urea. **Circle 94.**

Design and Construction, petrochemical plants (p. 97). Info from Lummus. **Circle 55.**

Design and Construction, steam reforming units (p. 99). Detailed engineering and economic data on new steam reforming process from M. W. Kellogg. **Circle 80.**

Fabrication, process equipment (p. IFC). Info from Wyatt Metal & Boiler Works Div., Wyatt Industries. **Circle 54.**

Fabrication, process equipment (p. 21). Booklet, "An Open Door" from Swenson Evaporator explains new approach to solving your processing problems. **Circle 5.**

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CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 101*

Compressors, diaphragm (p. 96). Bulletin 4071-"5" from American Instrument describes complete line of Corblin diaphragm-type pumps and compressors. **Circle 74.**

Computers (p. 80-81). Complete details on the "Dystac" computer from Computer Systems. Also 26-page report "Correlation and Optimization of Chemical Kinetics Models." **Circle 63.**

Computer, process control (p. 19-20). Complete technical data from Librascope Div., General Precision, on the Libratrol-1000 computer. **Circle 148.**

Contactors, multistage, continuous (p. OBC). Technical data from Mixing Equipment Co. on the "Lightnin CM-Contactor." **Circle 7.**

Controls, liquid-level (p. 158). For all types of liquids, horizontal, vertical, external mountings. Info from Jo-Bell Products on the "Level Master." **Circle 87.**

Controller, elapsed-time (p. 23). Specifically designed for batch operations where precise timing is essential. Catalog 08-705 from Daystrom, Weston Instrument Div. **Circle 100.**

Control Systems, visual (p. 169). Booklet BE-40 from Graphic Systems describes the "Boardmaster." **Circle 90.**

Conveyors (p. 150). Belt Conveyor Data Book (88 pages) from Continental Conveyor & Equipment. **Circle 46.**

Conveyor, skeleton-flight (p. 32). Info on the Redler conveyor in Bulletin 358 from Stephens-Adamson. **Circle 83-2.**

Conveyor, zipper (p. 32). Details in Bulletin 349 from Stephens-Adamson. **Circle 83-3.**

Conveyor System Components (p. 153). Catalog from Systems Engineering & Mfg. on blower units, conveying valves, automatic flow diverter, vacuum filter unit. **Circle 2.**

Crushers and Shredders (p. 150). For every application and capacity. Info from American Pulverizer. **Circle 19.**

Cylinder Valve Outlets (p. 25). Bulletin from The Matheson Co., Inc. **Circle 112-3.**

Deionizers (p. 146). From smallest laboratory to largest plant need. Bulletins from Elgin Softener. **Circle 45.**

Distributors, Support Plates, packed-tower (p. 86-87). Technical details in Engineering Manual TA-40 from U. S. Stoneware. **Circle 135.**

Dryers, spray (p. 100). Bulletin 51 from Bowen Engineering gives complete engineering info on new Centrifugal Spray Machine. **Circle 138.**

Dryers, spray (p. 126). Info from Nichols Engineering & Research on the Nerco-Niro dryer, specially designed for efficient drying of heat-sensitive materials. **Circle 53.**

Dryers, steam-tube (p. 116). Ruggles-Coles drryers available in aluminum, nickel, Monel, Inconel, stainless, other alloys. Specification in Bulletin 16-D-40 from Hardinge. **Circle 96.**

Dryer, turbo (p. 163). Packaged units up to 360 sq. ft. net, field units up to 18,000 sq. ft. net. Info from Wyssmont. **Circle 44.**

Dryer-Blender, conical (p. 113). Four production models, capacities from 2.6 to 165 cu. ft. Bulletin 963 from Pfaudler Permutit. **Circle 133-1.**

Dust Collectors (p. 134). Special designs for special applications. Info from Fly Ash Arrestor Corp. on "Whirlex" dust collection equipment. **Circle 107.**

Ejectors, jet (p. 29). Data Sheet J-2 from Schutte and Koerting lists types, special stock materials, sizes. **Circle 76.**

Ejectors, jet-vacuum (p. 146). New Folder from Jet-Vac. **Circle 35.**

Ethylene Recovery Units (p. 135). Prepackaged assemblies, capacities to 100 tons/day or more. Complete info from American Air Liquide. **Circle 59.**

Continued on page 104

MATERIALS *from page 101*

Gases, laboratory use (p. 25). Bulletin from The Matheson Co., Inc. gives details of three new gases for laboratory use—sulfur tetrafluoride, vinyl fluoride, allene. **Circle 112-1.**

Gases, industrial, compressed (p. 25). New Catalog from The Matheson Co., Inc. **Circle 112-2.**

Gases, industrial, compressed (p. 25). The Matheson Co., Inc. offers Wall Chart on "Safe Handling of Compressed Gases." **Circle 112-4.**

Gases, process (p. 83). Facts, figures, recommendations from Air Products. **Circle 42.**

Heat Transfer Cement (p. 147). Info on application of Thermon Heat Transfer Cement to asphalt heating problems. Engineering data from Thermon Mfg. **Circle 6.**

Metals, corrosion-resistant (p. 115). Data from Fansteel Metallurgical on tantalum, tungsten, molybdenum, columbium, refractory metal alloys. Also tantalum chemical plant equipment. **Circle 86.**

Plasticizer (p. 105). Union Carbide Chemicals offers prices, specifications on new Flexol Plasticizer EPO, high-molecular weight epoxy plasticizer with top-level compatibility in vinyls. **Circle 69.**

Polyethylene (p. 137-138). Info from U.S. Industrial Chemicals on use for sterile containers. **Circle 150-2.**

Resins, polyethylene (p. 137-138). Newly-developed polyethylene resins suitable for blow molding of bottles. Data from U.S. Industrial Chemicals. **Circle 150-4.**

Saran Materials (p. 156). Bulletin from Pyramid Plastics lists pipe, nipples, fittings, tubing, tube fittings, sheets, rods, molded pipe. **Circle 32.**

Silicones (p. 158). Manual from Dow Corning describes application of silicones in all phases of the process industries. **Circle 72.**

Sodium, metallic (p. 137-138). Info from U.S. Industrial Chemicals on new process for desulfurizing coal tar naphthalene with metallic sodium. **Circle 150-3.**

Synthetic Rubbers (p. 90). Data from Du Pont on industrial uses of Neoprene and Hypalon, particularly for hoses. Booklet "Du Pont Elastomers in Industry." **Circle 57.**

SERVICES *from page 101*

Fabrication, process equipment (p. 103). Technical data from C. G. Sargent's Sons on dryers, extruders, granulators, coolers, feeders. **Circle 66.**

Fabrication, process equipment (p. 114). Koven Fabricators specialize in intricate fabrication in stainless, aluminum, Monel, nickel, Inconel, all clad materials. Bulletin 550. **Circle 146.**

Fabrication, process equipment (p. 128-129). General American Transportation offers info on its new concept of "coordinated equipment." **Circle 81.**

Fabrication, process equipment (p. 139). Fabrication in all weldable materials, including, stainless, nickel, aluminum, silver, gold, titanium, tantalum. Bulletin 100 "Titanium Facts" from Nooter Corp. **Circle 70.**

Technical Books (p. 124). Info from Wiley & Sons. **Circle 101.**

FOR THE CHEMICAL PROCESS INDUSTRIES

SARGENT

DRYERS — Conveyor, Tray, Truck, Rotary Drum, Pole, Tunnel

EXTRUDERS — Preforms material into rods or other shapes

GRANULATORS — Roller Bar type, or with Paddles

COOLERS — Integral part of dryer housing; also separately

FEEDERS — Vibratory, or Oscillating, or Standard

From research lab through pilot plant to high volume continuous automatic production, SARGENT equipment is designed and engineered for your specific needs. After careful analysis of all factors and, where advisable, testing the product in our own drying research laboratory, our engineers submit recommendations as to type and size of equipment needed to provide required production and quality at the least cost per pound. If you wish, we welcome co-operation with your engineers to attain the same objective.

¶Broad experience with many materials in many fields enables us to guarantee fully and unconditionally the performance of every machine built by us.

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STARCH
TEXTILE FIBRES (Natural, Synthetic)
TOBACCO (Leaf, Cut Leaf, Film, Stem, Bundles)
VEGETABLES
WASTE SLUDGES
ZINC OXIDE

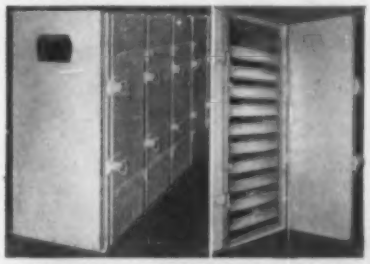
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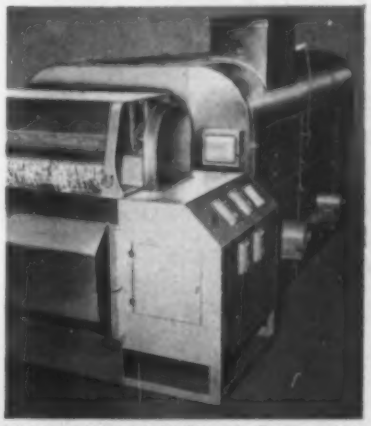
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TRUCK DRYER — Two compartment truck dryer installation in large chemical company. Controlled even heat distribution through all trucks. Economical, fast batch drying of many materials.



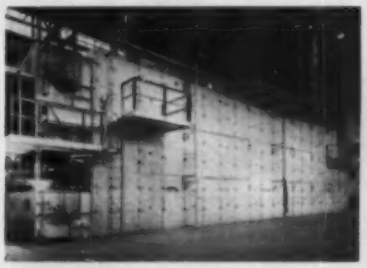
TRAY DRYERS — For safest, efficient drying of wet-powdered, heat-sensitive or unstable materials. Designed in any size, any number of trays. Heat flows evenly over each tray; no recirculation of air prevents contamination.



PILOT PLANT DRYER with Extruder and Cooler — Stainless steel throughout. Four foot single hopper extruder lined with stainless steel, cam type chrome plated paddles. Entire unit shipped pre-assembled.



PILOT PLANT Single Pass Dryer — For lab work, also for extra production. Offers amazing versatility at low cost. Heat source may be gas, oil, steam or electricity. Compact — this five-section dryer is only 17½ ft. long, 4½ ft. wide, 4 ft. high. Each section zoned and controlled separately.



SYNTHETIC RUBBER — Three-pass dryer. Direct gas-fired. All safety controls. Only two burners, which bring working temperature within ten minutes of start-up. This large dryer installed and working within four weeks.



KAOLIN — Single pass, two stage dryer with extruder to pre-form wet clay into rods. 20 drying sections, 2 cooling sections. Gas and oil combination burners, four zones, each with own heating system. Double hopper extruder for largest storage capacity.

For more information, turn to Data Service card, circle No. 66

EQUIPMENT *from page 102*

Extrusion Equipment (p. 136). Info from Davis-Standard describes equipment for precision extrusion control. **Circle 79.**

Fans, industrial (p. 18). Info from Garden City Fan & Blower on the "Thermal-Aire" fan, for temperatures to 1,850°F. **Circle 3.**

Filters (p. 93). Fast wet or dry cake removal and cloth washing without manual labor. Details in Bulletins from Niagara Div. of American Machine and Metals. **Circle 13.**

Filters (p. 118). Technical data from Purolator Products on any type of filtration problem. **Circle 88.**

Filters, drum, continuous-belt (p. 85). Data from Eimco on the new "Eimco-Belt" model. **Circle 75.**

Filters, pressure, rotating-leaf (p. 82). Complete info from Goslin-Birmingham on the Vallez rotating-leaf pressure filter. **Circle 106.**

Filters, vacuum and pressure (p. 94). Standard sizes from 5 to 800 sq. ft. of filtering area. Bulletins from FEinc Div. of American Machine and Metals. **Circle 14.**

Filter Materials (p. 161). Filter paper in all grades. Also filter cloth in cotton, wool, felt, glass, Orlon, Dynel, Saran, silk Dacron, polyethylene, Filyon, Nylon, etc. Info from Filpaco Industries. **Circle 151-1.**

Filter Media (p. 140). Bulletin 141 from T. Shriver lists filter media in cotton, synthetics, paper, wire mesh. **Circle 17.**

Filter Presses (p. 154). Catalog from D. R. Sperry also covers accessories such as closing devices, plate shifters. **Circle 99.**

Flowmeter (p. 157). Design Specification Sheet DS-361 from Brooks Rotameter gives details of the "MagPnu-Trax." **Circle 23.**

Flowmeters, turbine-type (p. 11) Info from Potter-Bowser Div., Bowser, Inc., on the "Pottermeter", available in capacities from 0.1 to 40,000 gal./min. Catalog covers this and other equipment. **Circle 103.**

FluoSolids Systems (p. 122). Technical data from Dorr-Oliver on the Dorrco fluid-bed reactor. **Circle 50.**

Gaskets, seamless, ring (p. 162). Full details from Southern California Oil Tool Co. **Circle 48.**

Gauges (p. 163). Ranges from 15 lb./sq. in. or 30 in. of vacuum to 20,000 lb./sq. in. Catalog from Kunkle Valve. **Circle 40.**

Heat Exchangers (p. 36). Heliflow offers technical info on new "Panaflow" design. **Circle 20.**

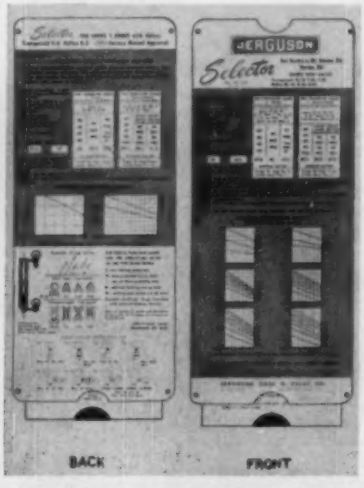
Heat Exchangers (p. 26). Standard models in stainless steel. Bulletin 158-HE from Doyle & Roth Mfg. **Circle 136-2.**

Heat Exchangers, panel-coil (p. 22). Data Sheet 15-60 Series and Price Bulletin 259 from Dean Products. **Circle 51.**

Heat Exchangers, plate-type (p. 10). Technical info from Chester-Jensen. **Circle 77.**

Heat Exchangers, zirconium (p. 137-138). Technical info from U. S. Industrial Chemicals. **Circle 150-5.**

DEVELOPMENT OF THE MONTH



GAGE AND VALVE SELECTOR (Circle 603 on Data Post Card)

A comprehensive slide selector for sizing gages and valves used for observation of liquids and levels is available from Jerguson Gage & Valve Co.

The Selector helps engineers specify gage dimensions for a variety of operating pressures and temperatures. Series 5, L-10, 20, and 30 gages with valves are included; also typical gage-valve combinations and standard angle valves are presented.

To obtain this Gage Selector, Circle 603 on Data Post Card.

Heaters, process (p. 143). Bulletin 1300 from International Boiler Works gives complete details of International-LaMont Aroclor Heaters. **Circle 95.**

Hortonspheres (p. 89). Full details from Chicago Bridge & Iron. **Circle 52.**

Icing Systems (p. 161). Technical info from Flakice Corp. **Circle 111.**

Indicator, bin level (p. 163). The "Bin-Dictator prevents bin overflow, conveyor clog, elevator choke-up, machinery damage, repair shut-down. Catalog BD-15 from Bin-Dicator Co. **Circle 31.**

Instruments, control (p. 28). Bulletin COM from West Instrument gives details of many types. **Circle 38.**

Joints, expansion, ball (p. 30). Choice of styles and sizes ½ to 16 in. Bulletin 31A from Barco Mfg. **Circle 8.**

Meters, liquid-level (p. 154). For measuring tank contents from any distance away. Bulletins from Uehling Instrument on the "Tankometer." **Circle 36.**

Mills, grinding, impact (p. 9). Lower percentage of fines or oversizes through control of impact velocity. Data from Entoleter, Div. of American Mfg. **Circle 92.**

Mixers, (p. 141). One pint to 5,000 gallon sizes, standard or custom designs. Info from Chas. Ross & Son. **Circle 109.**

Mixers (p. 141). One pint to 5,000 gallon sizes, standard or custom designs. Info from Chas. Ross & Son. **Circle 110.**

Mixers (p. 162). For any type of chemical materials. Data from Rapids Machinery. **Circle 97.**

Mixer, portable (p. 155). Technical info from Gabb Special Products on the new "Shear-Flow" mixer. **Circle 98.**

Nozzles, spray (p. 143). Catalog 1 from Monarch Mfg. Works. **Circle 89.**

Nozzles, spray (p. 163). Choice of over 12,000 basic designs. Complete Catalog 24 from Spraying Systems. **Circle 30.**

Nozzles, spray (p. 162). Capacities from ⅛ pint/min. to 4,000 gal/min. In bronze, cast iron, stainless. Catalog from Spray Engineering. **Circle 43.**

Packing, Teflon (p. 169). Catalog FF-1059 from Greene, Tweed on Palmetto packings. **Circle 9.**

continued on page 106



FEELS DRY... top compatibility with FLEXOL PLASTICIZER EPO

No oily film . . . no dirt pick up. These are the big advantages CARBIDE has built into FLEXOL Plasticizer EPO.

This premium-grade, high-molecular-weight, epoxy plasticizer demonstrates its top-level compatibility in vinyls even after hundreds of hours of rigorous testing. FLEXOL EPO gives your vinyl products full sales appeal at purchase, and lasting satisfaction in use.

Only two to seven parts of FLEXOL EPO per 100 of resin are required for stabilizing purposes. For dual use as a stabilizer-plasticizer, concentrations of only 10 to 50 per cent of the total ingredients are needed. Primary plasticizers such as FLEXOL DOP can be used easily with EPO.

FLEXOL EPO and other members of CARBIDE's big family of vinyl plasticizers are readily available in money-saving compartment tank cars and trucks, carloads, truckloads, and drums in LCL shipments.

For prices and full specifications on FLEXOL EPO, call the CARBIDE Technical Representative in your area. Or write: Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Ave., New York 17, N.Y.

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For more information, circle No. 69

CEP'S DATA SERVICE—Subject guide to advertised products and services

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 104*

Piping, glassed-steel (p. 113). Available off-the-shelf in any length to 10 ft. Info from Pfaudler Div., Pfaudler Permutit. **Circle 133-2.**

Preheaters, air (p. 77). Info from Air Preheater Corp. on the Ljungstrom continuous regeneration principle. **Circle 18.**

Pressure Vessels, stainless (p. 26). Technical data from Doyle & Roth Mfg. **Circle 136-3.**

Pulse Traps, liquid (p. 153). For all types of rotary, reciprocating, and plunger pumps. Technical data from Pulsation Controls. **Circle 22-2.**

Pulverizers (p. 147). The "Micronizer" can provide fines in range from ½ to 44 microns. Info from Sturtevant Mill. **Circle 47.**

Pumps, centrifugal, self-priming (p. 79). Complete technical data from LaBour. **Circle 10.**

Pumps, chemical, small (p. 107). In wide variety of metals and non-metallics for every corrosion and contamination problem. Technical data from Eco Engineering. **Circle 82.**

Pumps, diaphragm (p. IBC). Capacities to 224 gal./hr., pressures to 2,500 lb./sq. in. Bulletin 1157-3 from Milton Roy. **Circle 49.**

Pumps, metering (p. 98). Rates to 15.7 gal./min., pressures to 7,000 lb./sq. in. ga. Catalog 59 from Lapp Insulator. **Circle 78.**

Pumps, peristaltic action (p. 160). Capacities from 1 cc to 250 cc/min. Ideal for column chromatography. Technical data from Sigmamotor. **Circle 108.**

Pumps, process (p. 125). Bulletin 203-8 from Lawrence Pumps gives complete story on chemical and process pumps. **Circle 104.**

Pumps, rotary (p. 151). Capacities from 1 to 2,000 gal./min., viscosities from 32 to 1 million SSU, discharge to 1,000 lb./sq. in. for viscous liquids, 200 lb./sq. in. for water and light oils. Info from Sier-Bath Gear & Pump. **Circle 85.**

Pyrometers, surface (p. 148). Eight models with temperature ranges from 0-300°F to 0-2,000°F. Bulletin 4257 frrom Alnor Instrument on the "Pyrocon." **Circle 56.**

Pyrometers, surface (p. 160). Bulletin 194-SR from Cambridge Instrument. **Circle 24.**

Reflux Splitter, automatic (p. 149). Pyrex and Teflon construction provides complete corrosion resistance. Bulletin RS-2 from Chem Flow. **Circle 84.**

Regulators (p. 153). Marotta Valve offers Correlation Booklet on the RV-23 Regulator Series. **Circle 93.**

Regulators, pressure, pilot-operated (p. 27). Bulletin 471A from Kieley & Mueller gives technical details of the new Type 471 External Pilot Pressure Regulator. **Circle 64.**

Screeners (p. 156). The "Vorti-Siv" screens powders, liquids, slurries in 4 to 400 meshes. Data from J. M. Lehmann. **Circle 33.**

Scrubbers, fume, jet-Venturi (p. 34). Complete Catalog from Croll-Reynolds. **Circle 41.**

Separators, entrainment (p. 4). Bulletin 21 from Otto H. York describes applications of York Demisters. **Circle 102.**

Separators, entrainment, knitted-wire (p. 18). Latest design guides in Bulletin ME-9 from Metal Textiles Corp. **Circle 91.**

DEVELOPMENT OF THE MONTH



COMPUTER CONTROL SYSTEM (Circle 601 on Data Post Card)

A completely integrated computer control system, said to be the first to combine instrumentation from primary elements to final controls, has been introduced by Minneapolis-Honeywell Regulator Co.

The Honeywell 290, as it is named, was designed specifically for large-scale processes, such as electric power generation, petroleum refining, chemical and cement manufacturing, etc. It features parallel operation, random access, high computation speed, magnetic core and auxiliary magnetic drum memory, and special instruction vocabulary.

Described as the most powerful in the moderate price field, the computer can perform 8000 additions or subtractions, 1250 multiplications, or 400 square root extractions per second.

For more information, Circle 601 on Data Post Card.

Separation Equipment, liquid-solids (p. 91). American Machine and Metals offers complete integrated service. Technical info. **Circle 11.**

Tanks, rubber-lined (p. 154). Complete data from Gates Rubber Co. on storage tanks for corrosive liquids. **Circle 134.**

Tanks, stainless (p. 26). From 500 to 15,000 gal. Bulletin 1159-"SC" Series from Doyle & Roth Mfg. **Circle 136-1.**

Tanks, stainless (p. 161). For storage and mixing in all styles. Data from Filpaco Industries. **Circle 151-2.**

Thermocouple Wire, sheathed (p. 142). Bulletin 1200-4 from Claud S. Gordon gives technical details, ordering data, prices on "Serv-Rite" wire and accessories. **Circle 34.**

Tubing, finned (p. 119-120). Info from Wolverine Tube on "Trufin" tubing, available in steel, copper, copper alloys, aluminum. **Circle 149.**

Tubings, technical (p. 152). Precision-extruded tubings in Teflon, silicone rubber, vinyl, polyethylene, rigid vinyl. Data and Prices from L. Frank Markel. **Circle 68.**

Valves (p. 117). Wide variety of materials for plug facings and valve bodies. Technical info from DeZurik. **Circle 58.**

Valves, ball-plug (p. 14). In wide range of sizes and ratings, including worm-gear and motor-operated models. Info from Hydril in Catalog V-60. **Circle 62.**

Valves, butterfly (p. 148). In any size or metal for wide range of temperatures, fluids, pressures. Info from Fisher Governor. **Circle 16.**

Valves, control (p. 31). Details on complete line from Annin. **Circle 60.**

Valves, diaphragm, jacketed (p. 157). Size range from 1¼ to 4 in. Details and dimensions in Supplement Catalog 356-S from Parks-Cramer. **Circle 67.**

Viscometers (p. 110). Engineering data on many types from Brookfield Engineering Laboratories. **Circle 61.**

Weighers, continuous (p. 32). Bulletin 958 from Stephens-Adamson. **Circle 83-1.**

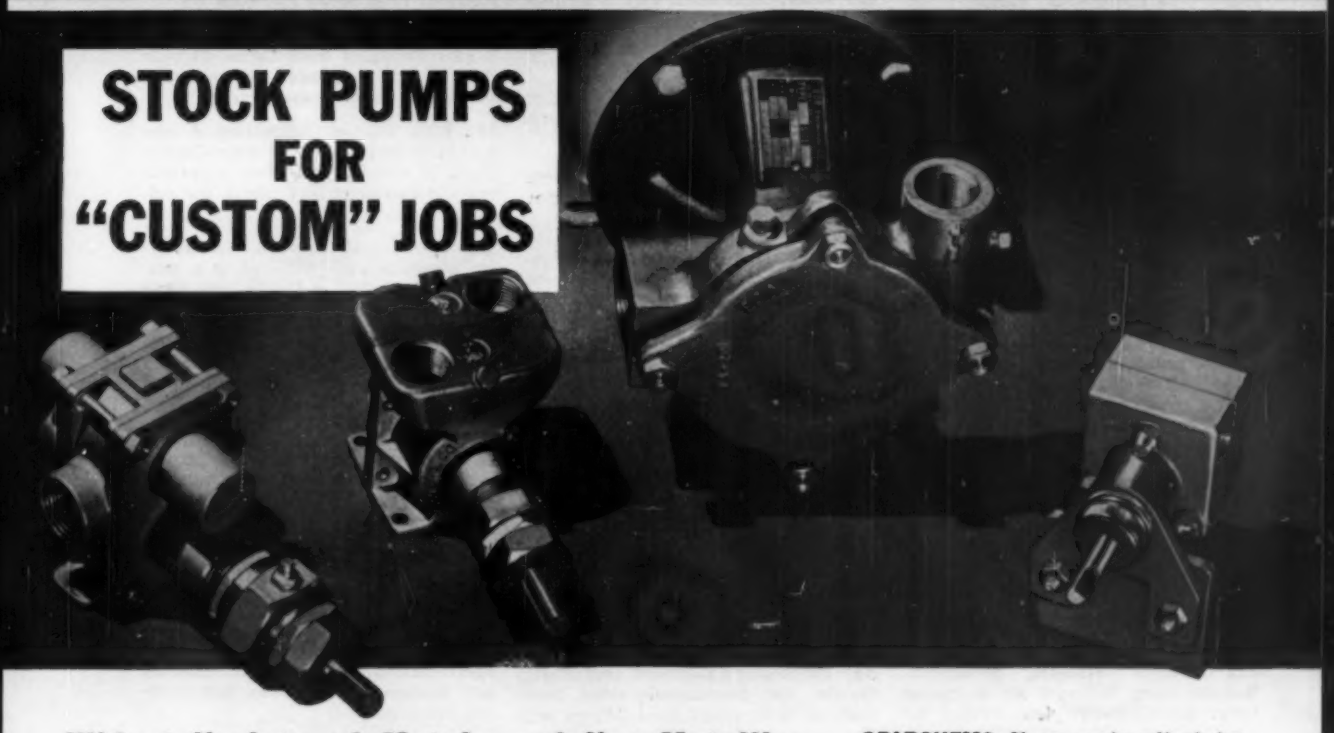
Weighing Equipment (p. 5). Catalog 101, "W-E" from B. F. Gump gives details of the Edtbauer Duplex Net Weigher. **Circle 37.**

Wire Cloth (p. 84). In all widths, all meshes, all malleable metals. Technical info from Newark Wire Cloth Co. **Circle 4.**

For more information, circle No. 82 ➤

ECO ENGINEERING NEWS

the big name in small pumps for the process industries



STOCK PUMPS FOR "CUSTOM" JOBS

Widest Variety of Metals and Non-Metallics For Every Corrosion and Contamination Problem

Only in high priced, slow delivery "custom built" pumps are you able to secure anything approaching the variety of special metals and non-metallics offered in the Eco line of standard, stock, Chemical Pumps. Reason for the great versatility of these pumps in meeting the requirements of all commercial chemicals, acids, oxidants, alkalies, aromatics and solvents, including the most reactant and hazardous fluids.

Metals used in Eco Pumps embrace the stainless steels 304, 316 and Carpenter 20; Stellite*, Hastelloy* B and C, monel, nickel, zirconium and titanium. Non-metallics include Teflon†, phenolic plastic resins, Hypalon†, Nylon, Penton‡, ceramic, carbon, etc.

Complete Interchangeability of Parts

Precision uniformity in manufacture permits complete interchangeability of parts, allowing unlimited combinations of housing and trim materials to exactly meet customer's requirements and to facilitate field servicing or conversion of pumps to new services.

Mass Produced and Stocked for Quick Delivery

Eco Pumps are produced in volume on automatic "program" machine tools of advanced design, where multiple operations are performed to reduce needless labor and handling. This results in lower prices to the user.

It also insures at all times, a large stock of complete pumps and part sets ready for immediate delivery.

It will pay you, as it has many others, to standardize on Eco for all small chemical pump requirements. Write for literature on the complete Eco line.

GEARCHEM®: If you require self-priming and intermittent or sustained operation with constant flow metering and reproducible accuracy within ± one per cent, depending on viscosity—select the Eco GEARCHEM Pump. For temperatures to 400°F, viscosities to 10,000 SSU, capacities to 10 gpm, pressures to 100 psi.

ALL-CHEM®: If you want linear, non-segmented, non-foaming flows, ideal for shear sensitive emulsions and safe for auto-detonating fluids—select the Eco ALL-CHEM Rotary positive displacement pump. For reduced viscosities and temperatures to 250°F, capacities to 10 gpm, pressures to 75 psi.

CENTRI-CHEM®: If you want a widely applicable centrifugal pump handling most chemicals including slurries with particle size up to 1/16", as well as troublesome sticky fluids—select the Eco CENTRI-CHEM. Capacities to 40 gpm, heads to 57 ft.

MINILAB®: If you want an all-purpose laboratory and pilot plant pump to handle severe corrosives, 'round the clock—select the Eco MINILAB. Capacities from 0 to 2 gpm, pressures to 100 psi. Reversible, self-priming. Yields linear flow ideal for constant flow metering.

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SUBJECT GUIDE to free technical literature

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT

301 Blower. Information from Systems Eng. and Mfg. Co., Inc. gives details of new blower unit consisting of piston or rotary type compressor, motor, V-belt drive, and air intake filter silencer.

306 Computer System. Technical Report "A Digital Data Logging and Computing System for Nuclear Reactors" from Packard Bell Computer features PB 250.

307 Condenser. Details available from Niagara Blower Co. for new high capacity vapor condenser with 30 million Btu/hr. capacity.

308 Control, liquid level. Information for new model KT-Tandem control for liquid levels is available from Jo-Bell Products, Inc.

309 Control System, fractionator. Complete Technical data from Swartwout Div., Crane Co. describes new computer controller that stabilizes tower operation.

310 Controller, pneumatic. Details covering operation of controller used to regulate a metering pump is available from Wallace & Tiernan Inc.

311 Controls, gamma radiation. New Catalog lists variety of industrial instruments and controls made by Instruments, Inc.

312 Conveyor Systems, pneumatic. Bulletin from National Air Conveyor Corp. describes complete service for handling wet or dry materials.

314 Data Handling System. New 4-page Data Sheet from Leeds & Northrup Co. describes 600-channel sequential data handling system.

315 Demineralizers. A new 36-page Catalog features complete line of mixed-bed, two-bed, four-bed demineralizers from Barnstead Still and Sterilizer Co.

316 Density Gages, nuclear. Data Sheet from Ohmart Corp. describes nuclear gage used in sludge measurement and control.

318 Equipment, mining. Bulletin G-11 lists non-metallic mining and processing equipment offered by Fuller Co.

319 Feeders, vibrating. Folder 2770 from Link-Belt Co. describes new Straightline vibrating feeders.

320 Filter, acoustic. Bulletin 201A presents details of hydraulic noise filter from Pulsation Controls Corp.

325 Hose, chemical resistant. Bulletin from Resistoflex Corp. lists applications, properties, dimensions for Fluoroflex and Compar hose.

327 Instrumentation, industrial water. Bulletin B96-2 from Minneapolis-Honeywell Regulator Co. discusses instrumentation for water treatment.

329 Mixer, continuous. Details for new continuous muller-type mixer from Simpson Mix-Muller Div. of National Eng. Co.

330 Mixer, hydraulic. Information from The Stevenson Co. describes automatic mixer for emulsions and pastes.

331 Mixer, industrial. Bulletin from Gabb Special Products Inc. describes Shear-Flow industrial process mixer.

332 Mixer, portable and fixed. Two new Bulletins from Mixing Equipment Co. describes Lightnin portable and fixed mounting mixer line.

333 Mixers, horizontal. Bulletin 128-A from Sprout, Waldron & Co. gives compact information on modern horizontal mixers.

334 O-Rings, silicone. Information concerning new silicone rubber compound for O-rings and molded shapes from Stillman Rubber Co.

336 Process Equipment. New 20-page Bulletin 16-P contains information on solids processing and heat transfer equipment from Patterson-Kelley Co., Inc.

337 Processing Equipment, centrifugal. Details for mechanically-aided heat transfer units called Ajust-O-Films and Thermalizers for process industries from Kontro Co., Inc.

338 Processing Equipment, continuous. A 16-page Brochure lists characteristics and applications of 55 types of equipment manufactured by Dorr-Oliver Inc.

344 Pumps, canned. Bulletin from Goulds Pumps, Inc. describes pumps for handling inflammable liquids up to 100 gal./min. and heads to 100 ft.

346 Pumps. A Technical Bulletin "Over-all Specific Speed as a Definition of Pump Type" is offered by Dean Brothers Pumps Inc.

347 Refrigerated Storage Facilities. An 8-page Brochure from Chicago Bridge & Iron Co. describes design and function of facilities for storing liquefied gases to —50°F.

349 Regulators, temperature. New 8-page Catalog from OPW-Jordan contains info on complete line of sliding gate and plate temperature regulators.

350 Rings, adapter. A Bulletin from Greene, Tweed & Co. introduces new Sealsaver adapter rings.

continued on page 110

MATERIALS

359 Acetonitrile. A new 56-page Guide Book of reactions, physical properties, uses, bibliography of acetonitrile is available from Sohio Chemical Co.

360 Adhesives, vinyl ethyl ether-based. A new Brochure from Union Carbide Plastics Co. describes polymer base for pressure-sensitive adhesives.

361 Butyl Rubber, vulcanizing. A new 8-page Technical Booklet from Catalin Corp. of America describes heat-reactive dimethylol phenol resins for vulcanizing rubber.

362 Chelation Materials. A chart showing potential savings by using a mixture of hydroxyacetic acid and citric acid is available from DuPont Co.

363 Chemicals. A 16-page Bulletin reviews 94 organic and inorganic chemicals produced by Hooker Chemical Corp.

365 Elastomers, high temperature. Data Sheets from Haveg Industries, Inc. describes oil and fuel resistant elastomer based on DuPont's Viton B polymer.

367 Graphite Cloth. Properties of graphite cloth are outlined in Bulletin 101 from National Carbon Co.

368 Methanol. A 32-page Book from Commercial Solvents Corp. covers specifications, technical data, handling and storage, toxicity, uses, test methods for methanol.

369 Olefin, Terpene Epoxides. A Technical Bulletin discusses use of olefin and terpine oxides as reactive diluents in epoxy resin formulations. Food Machinery and Chemical Corp.

continued on page 110

SERVICES

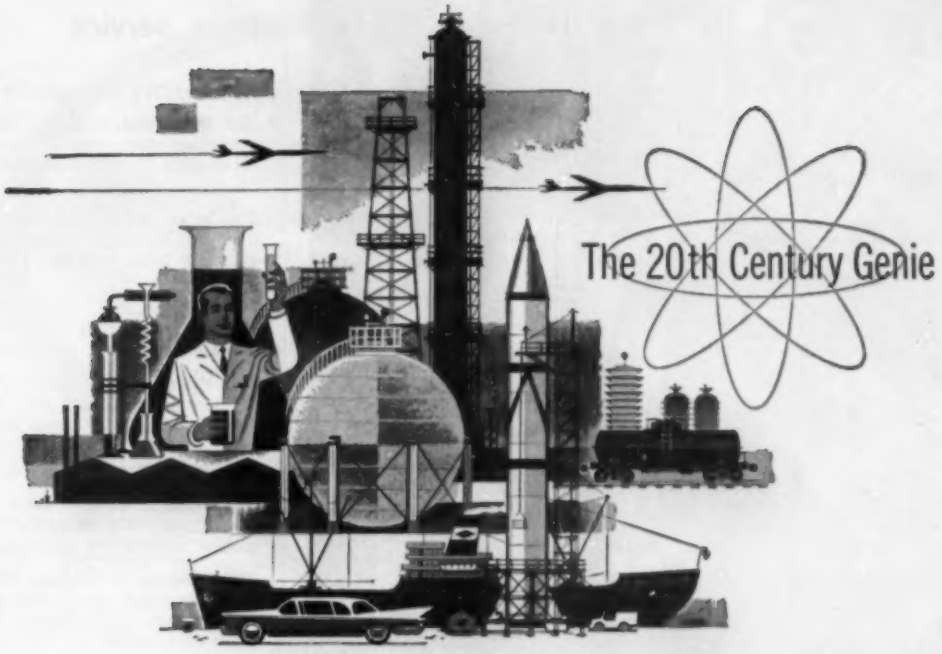
381 Blow Molding. Technical Brochure explains effects of polyethylene resin properties on blow molded products. Details from U.S. Industrial Chemicals Co.

382 Computer. A 26-page Report entitled "Correlation and Optimization of Chemical Kinetics Models" using DYSTAC analog computer is available from Computer Systems, Inc.

383 Copper Refinery. A 16-page Brochure from M. W. Kellogg Co. describes new copper refinery of the Kennecott Refining Corp.

384 Economics. Booklet entitled "Low First Cost vs. Low Ultimate Cost" are available from the Heat Exchanger Div. of Western Supply Co.

continued on page 110



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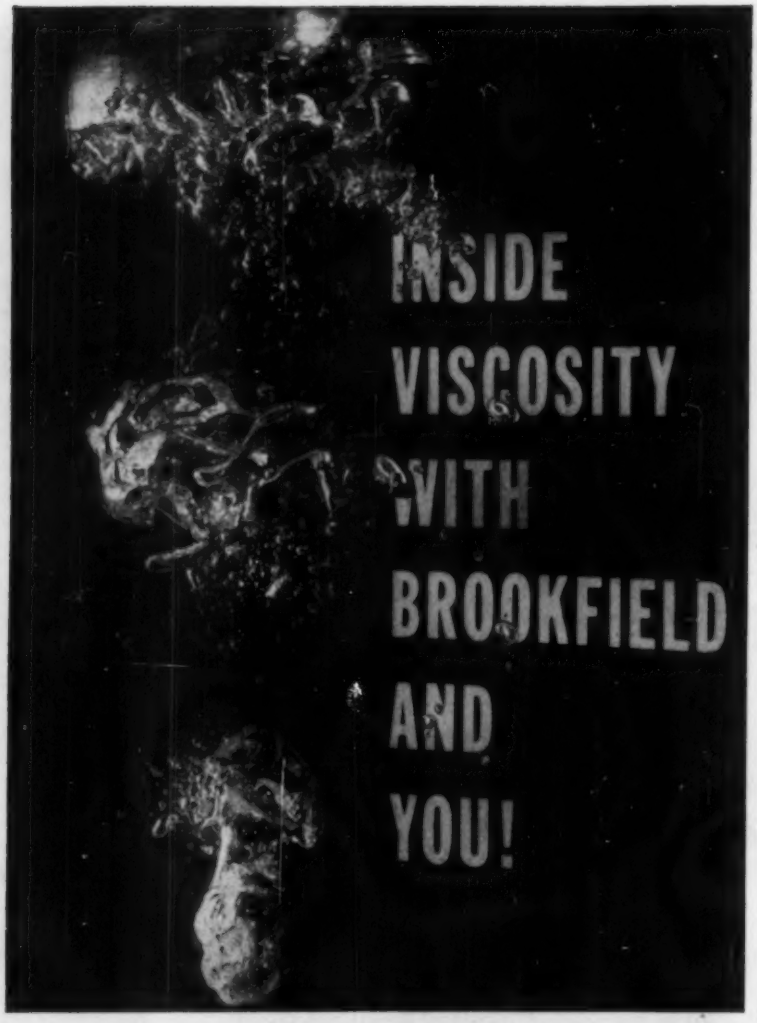
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Hydrofluosilicic Acid
Lead Fluoborate
Lithium Fluoride
Metallic Fluoborates
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Data service

EQUIPMENT *from page 108*

351 Rotameter, magnetic. Bulletin 18A describes new type magnetic alarm rotameters from Schutte and Koerting Co.

355 Valve, diaphragm. Data describing 8-in. Penton-lined diaphragm valves available from Hills-McCanna Co.

357 Valves, PVC. Information from Hoke Inc. describes line of ball valves made from type I, unplasticized PVC.

358 Valves, thermoplastic. Bulletin describes unplasticized PVC ball valves from Tube Turns Plastics Inc.

MATERIALS *from page 108*

372 Plastics. Bulletin BR-4 from Polymer Corp. lists available TFE-fluorocarbon shapes and fabricated parts.

373 Plastics. A 16-page Catalog AD-177 lists stock shapes and parts made from Teflon, CTFE, Delrin, Nylon, etc. from Garlock Inc.

374 Polyethylene Resin. A 24-page Booklet from U.S. Industrial Chemicals Co. describes bulk handling of polyethylene resins.

377 Resin, cation exchange. Bulletin from Rohm & Haas describes high capacity Amberlite 200 cation exchange resin.

380. Silicones. Reference Manual 1-119 "How Silicones Work for the CPI" is available from Dow Corning Corp.

SERVICES *from page 108*

385 Engineering Services. Folder from Vitro Eng. Co. presents summary of experience and services.

386 Engineering Services. A 19-page Brochure describes engineering and construction services offered by The Lummus Co.

388 Reclaiming Alumina. Bulletin from Fuller Co. shows how alumina yields were boosted by specialized reclaiming process.

389 Solids Mixing. Technical article reprinted from CEP describes design and performance criteria for vertical and horizontal mixers and blenders. Sprout, Waldron & Co., Inc.

A.I.Ch.E. Membership

Brochure—"Know Your Institute"—tells objective aim and benefits to chemical engineers who join this nation-wide organization, includes membership blank. Circle number 600 on Data Post Card.

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Electron micrographs showing Micro-Cel grade distinctions.

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4½ lbs. of Micro-Cel®, Johns-Manville's new line of synthetic calcium silicates, bulk to a full cu. ft. Absorbs up to 6 times its weight in water. Costs only 7 to 8¢ a lb. (F.O.B.). Surface areas up to 175 sq. m/gr. If you need a filler to absorb liquids, prevent caking, control viscosity, extend pigments, aid suspension or reduce surface sheen, Micro-Cel is the cost-cutting answer. Mail coupon for information, samples and assistance!

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equipment feature

Radiant heating speeds up batch processing

Processing time cut in half, fuel and labor economies effected by Selas Corp. installation at Warren Refining & Chemical.

MAJOR ECONOMIES IN BATCH processing of lubricating oils and greases are claimed at Warren Refining & Chemical, Cleveland, following replacement of a steam heating system by a radiant heating installation designed and built by Selas Corp. of America.

In the Warren installation, two groups of "Duradiant" burners in the setting (Figure 3) are supplied with gas and air in the proper mixture by low-pressure inspirators. Radiant heat is then created by burning the controlled gas-air mixture against the special refractory surfaces of the burners. The cup surfaces, in turn, beam the radiant heat to the kettle bottom, which is located only 10 inches above the burners.

An accelerated heating rate in processing each batch of heavy lubricants is achieved by a combination of controlled rate of heat transfer and close proximity of the heat source to the kettle. This proximity is possible because the burners produce no harmful flame impingement on the bottom of the kettle to cause hot spots or charring of the finished lubricant.

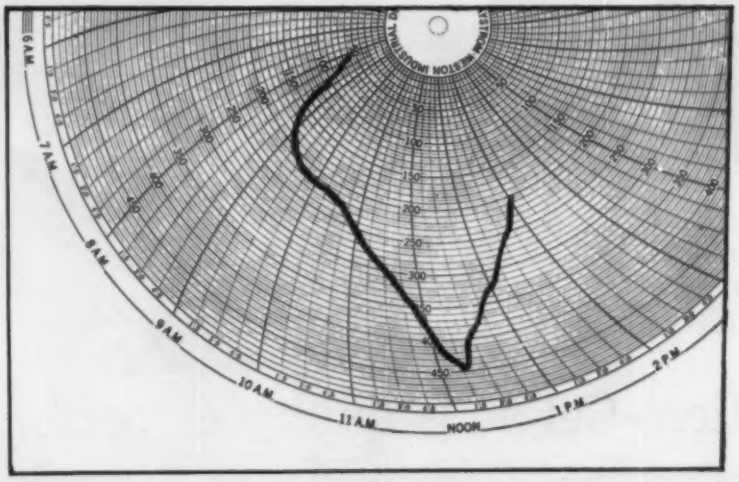


Figure 1. Recorder chart showing rapid temperature rise at start-up, smooth leveling off, fast climb to peak level after additive has been blended in at 220°F. Also note fast dissipation of heat.

Combustion is complete within each cup.

Processing time cut

The new radiant-heat system, says Warren Refining & Chemical, has reduced the time for heat processing a full batch of lubricant from 8 to 4 hours, enabling the plant to complete two full batches a day, instead of one; it has also cut fuel and labor costs in half.

A typical operation begins with the pumping of several hundred gallons of base oil into the kettle above the radiant-heat setting. Simultaneously, two sets of counter-rotating, scraper-type paddles in the kettle are started. The burner setting is then ignited electrically, and the temperature brought rapidly to about 160°F. A moderate amount of thickening agent —calcium-soap, lithium-soap, or soda-soap, depending on the lubricant being processed—is next added to the batch. The temperature rise is continued at a gradually decreasing rate to 220°F. After a few minutes at this level, it is again increased rapidly from 220 to 445°F in a little less than 1½ hours.

Once the temperature reaches the peak level—which varies from 300 to 450°F, depending on the flash point of the base oil being used—the burners are turned off. The batch is then com-

continued on page 114

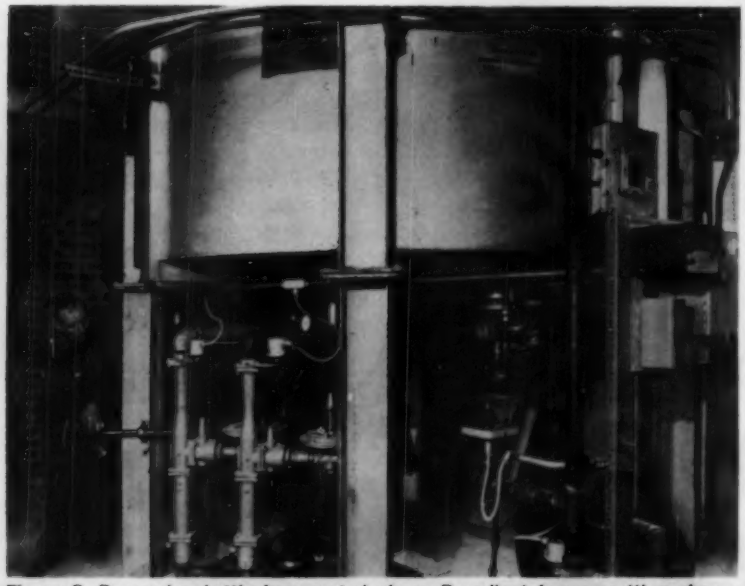
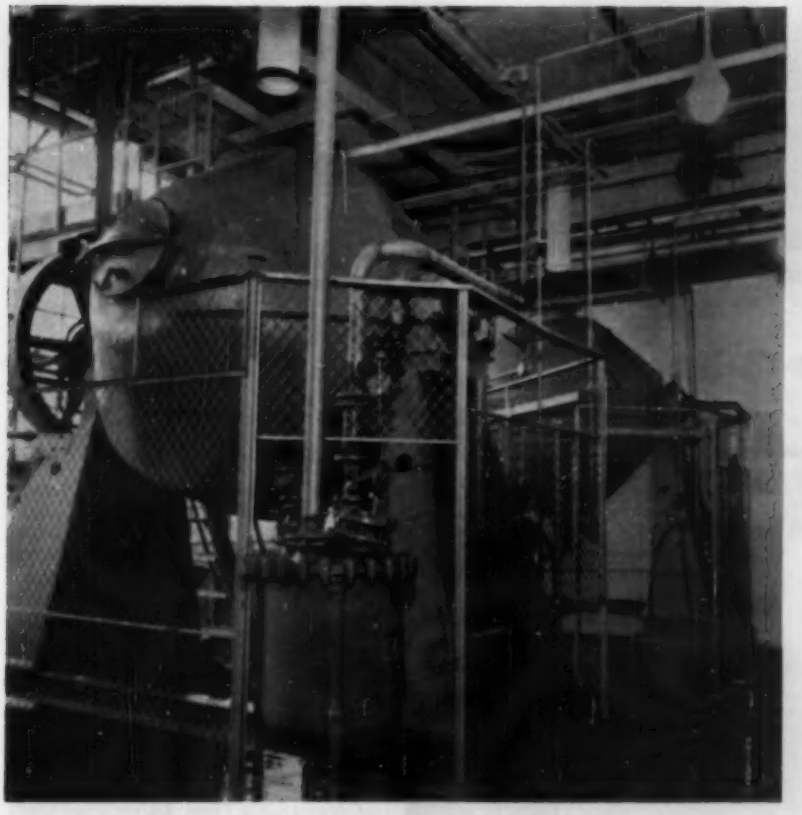


Figure 2. Processing kettle is mounted above Duradiant burner setting shown. Operator is opening kettle discharge valve for finished batch.

FLUIDICS* AT WORK



How Merck achieves uniform drying

If your process involves bulk drying, you will be interested in how Merck & Co., Inc., handles it at their Flint River plant.

Here, Pfaudler® Conical Dryer Blenders are used to dry a coarse crystalline, acid-salt intermediate, and a fine crystalline, white finished product under closely controlled vacuum and temperature conditions.

Feed goes in with moisture content of approximately 25% and comes out with a residual moisture of less than 1%. The thorough tumbling action achieves a constant, uniformly blended product as evidenced by the quality of the test samples.

And, since product is bulk charged directly into the dryer and discharged into shipping containers, Merck has minimized their product handling.

Resists corrosion. You can use the Pfaudler Conical Dryer Blender with all acids (except HF) and most alkalies without concern over corrosion, since the interior is Glasteel.

Protects purity. This inert glass product-contact surface also protects product purity. Because glass is fire-polished *smooth*, there's little build-up so cleaning is quick and complete.

Versatile. This unit can also be used for impregnating, concentrating, reacting and coating—all in a *single* operation. Such versatility makes further savings possible in capital investment, time, and floor space.

Choice of models. There are four production models with capacities from 2.6 to 165 cubic feet as well as a ⅓ cubic foot lab unit for test purposes. *Ask for Bulletin 963.*

Cut to order . . . F-C Glasteel pipe†



Immediate delivery is what you can get when you need odd-size lengths of a corrosion-resistant, high-integrity lined pipe in lengths to 10 feet. That's the availability story on F-C pipe when ordered to size from our factory.

Do it yourself

The F-C means "field cut" and also means you can do it in your own plant with almost any standard dry-abrasive cutoff wheel. After that it's a simple matter of threading, fire-polishing (using a small, portable furnace available from Pfaudler) and finishing with a belt sander.

Resists corrosion

Glass lining for this pipe is ⅛ inch thick, so you can expect substantially long service life even with corrosive and/or abrasive fluids. Rated at 150 psi, F-C pipe is available in 1½, 2 and 3-inch diameters. Use it with all acids (except HF) to 350° F., and with all mild alkalies at moderate temperatures.

Protects purity

Also, since glass is *inert*, you can use this pipe with products that must be kept free from contamination. And because it's *smooth*, there's little chance for build-up, even with sticky materials.

Remember: It's "off-the-shelf" for F-C pipe in any length to 10 feet.

†Patent applied for

Address all inquiries to our Pfaudler Division, Dept. CEP-90, Rochester 3, N. Y.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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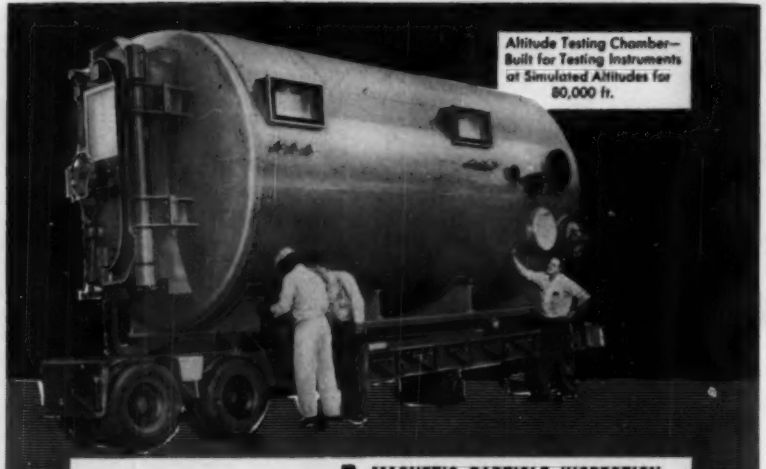
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Radiant heating

from page 112

pleted with the introduction of several hundred more gallons of base oil. The batch is then allowed to cool to 200°F before being pumped out. This operation takes only about 1¾ hours, compared to about 4 hours with the steam heating system formerly em-

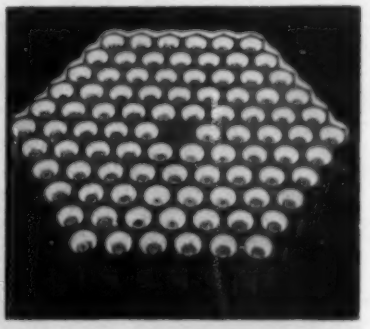


Figure 3. Typical Selas-built "Duradiant" setting, which provides radiant heat by burning closely-controlled gas-air mixtures against special cup-shaped refractory surfaces.

ployed. Rapid dissipation of heat from the radiant burners is a vital factor in the quick cooling time. When the batch reaches 200°F, the finished lubricant is pumped from the kettle into containers for shipment.

Based on a report "Change to Radiant Heating for Processing Lubricating Greases Cuts Time, Labor, Fuel Costs 50%," by Ian L. Carmichael, Warren Refining & Chemical, Cleveland, Ohio.

A new section of U.S. Industrial Chemicals polyethylene plant at Houston, Texas, doubles plant capacity. Company total capacity of low and medium density polyethylene resins is now up to 300 million pounds a year, making U.S.I. one of the world's largest producers of polyethylene.

Added to the list of U.S. gasoline additive producers is Houston Chemical, with a 10 million construction project for tetraethyl and tetramethyl lead now underway at Beaumont, Texas. Supervision of construction of the new plant is in the hands of T.R. Young, vice president in charge of operations.

A major expansion in Du Pont's sulfuric acid plant at Wurtland, Ky. gets underway shortly. A new bulk acid terminal will also be established near New Cumberland, W. Va. to service Eastern Ohio and Pittsburgh areas, and to handle shipments from the new Wurtland plant.

Need Acidproof Equipment In A Hurry?

FANSTEEL'S NEW WAREHOUSE CAN SHIP Within Hours!



A new construction order for 36" tantalum tapered condensers, 1"x 18" single tube tantalum bayonet heaters, assorted tantalum screws shipped complete same day received.

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6 x 2 x 60" tantalum tapered condenser ordered and shipped the same day.

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Now it's easy for you to meet or beat production deadlines, prototype or pilot plant completion dates. At right are just a few examples of the new Fansteel warehouse service which hundreds of manufacturers have already used.

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Tantalum Tungsten Molybdenum Columbium Refractory Metal Alloys	wire, rod, foil sheet, plate
Tantalum Chemical Plant Equipment	bayonet heaters, heat exchangers, coils, thermowells, tubing

Also many other products, plus complete processing service, technical assistance.



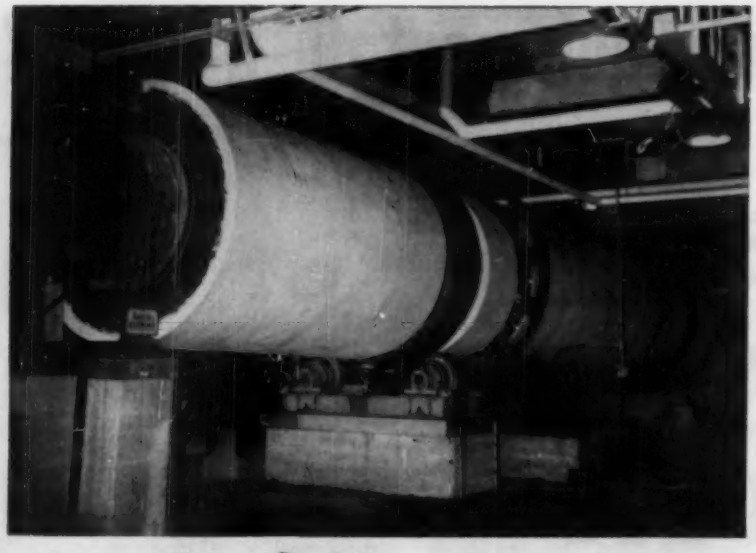
FANSTEEL

Write to Chemical Equipment Department, Metals and Fabrication Division, for your copy of the Fansteel Warehouse Price and Stock List . . . or contact your local Fansteel representative.

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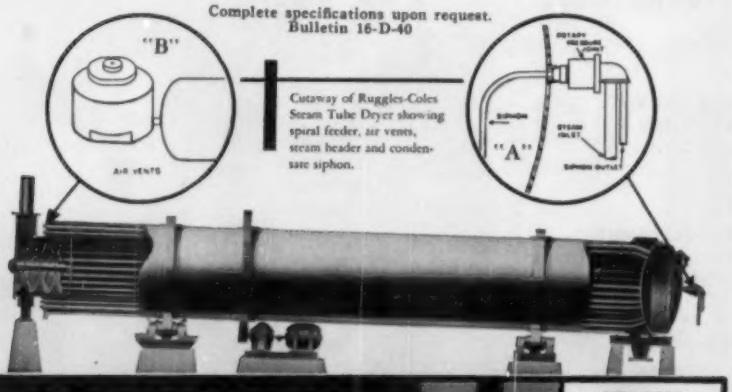
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Ruggles-Coles STEAM TUBE DRYERS

- Ruggles-Coles Steam Tube Dryers have been supplied fabricated of aluminum, nickel, monel, inconel, stainless steels and other alloys to provide protection against corrosion and contamination. All fabrication is to code requirements.
- The continuous siphon discharge of condensate is independent of speed of rotation of the shell. (See "A")
- Automatic air vent for each tube eliminates loss of tube heating surface at the feed end of the dryer. (See "B")
- These extra advantages of the Ruggles-Coles Dryer mean continuous maximum output without operating attention and elaborate control devices.

Complete specifications upon request. Bulletin 16-D-40



Cutaway of Ruggles-Coles Steam Tube Dryer showing spiral feeder, air vents, steam header and condensate siphon.

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industrial news

New Esso Dutch refinery

THE NEW ESSO REFINERY, now on stream in Rotterdam, The Netherlands, will supply the company's requirements for the Dutch market, with the balance slated for export. The $50 million, 100,000 bbl./day installation is located on the Third Petroleum Harbor, part of the extensive Maas waterways system in the Rotterdam area. It has 2260 meters of waterfront facilities, including piers which can handle two 50,000 dwt supertankers at once. It stands on 275 acres of filled-in land.

The Esso Nederland refinery is one of the first on the continent equipped with electronic controls. The equipment used by the system occupies approximately 40% less panel board space than conventional types of controls. Catalytic reforming is done by Esso's Powerforming Process, using a continuous unit. Other units include crude distillation, naphtha stabilizer, hydrofiner, copper chloride treater, electronically controlled loading system, and tankage and other ancillary facilities.

Engineering was by Badger.

A substantial interest in the Dutch chemical firm, N.V. Fabriek van Chemische Producten, at Vondelingenplaat, The Netherlands, has been acquired by Pennsalt Chemicals. A $2 million expansion in manufacturing facilities for tertiary dodecylmercaptan gets underway immediately at the Vondelingenplaat location. Pennsalt also plans to introduce the Dutch company's pesticide line on this continent in 1961.

One of the world's largest petroleum naphthalene plants will be constructed at Sun Oil's Toledo, Ohio, refinery. The 100 million pound a year facility will supply users who until now have depended on the coal-tar industry and coke-ovens, and on some imports. Contract for the $8 million unit went to M.W. Kellogg.

Expansion of the orthoxylene plant of Humble's Enjay Chemical Co. will bring production capacity to 72 million pounds at the Baytown, Texas, site. Plans call for an increase to 165 million pounds a year if demand warrants.

DeZURIK VALVES....

...so much to offer on any installation!



With their easy operation, dead tight shut off, freedom from lubrication and other maintenance, DeZurik Valves offer still more advantages to the processing plant where corrosion, erosion or contamination is a factor.

A wide variety of materials is available for plug facings and valve bodies, allowing an almost "custom-designed" DeZurik Valve.

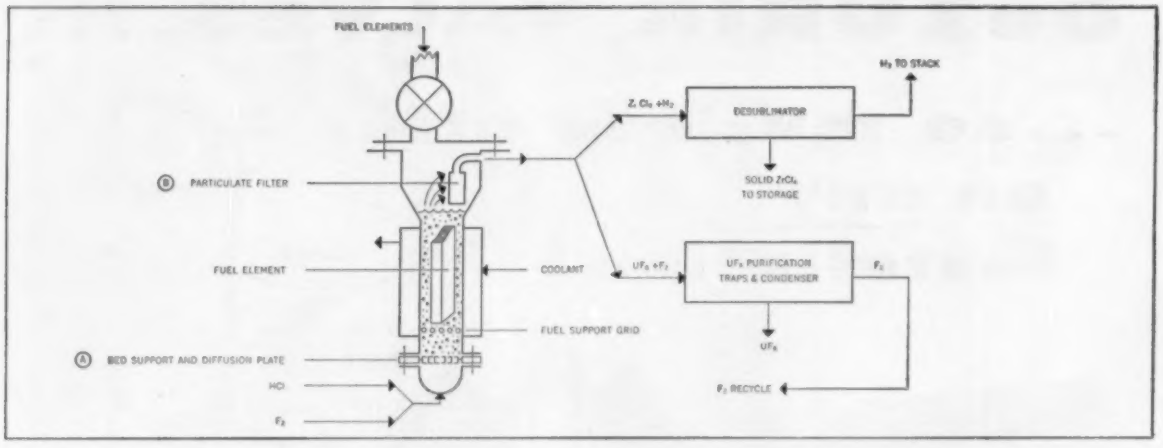
Plugs can be faced with Neoprene, Hycar, Teflon, Hypalon, Viton and other compounds which offer resistance to the deteriorating action of most chemical services. Metal faced plugs are available for use on extremely high temperature services.

Valve bodies are available in semi-steel, bronze, acid resisting bronze, Ni-Resist, aluminum, carbon steel, ductile iron, stainless steel, Alloy 20, Monel, nickel and other alloys. They can also be supplied with platic coatings and hard or soft rubber linings.

Whatever problems your applications present, there's sure to be a DeZurik Valve that will handle it easier, better, with less trouble, longer! Why not ask the DeZurik representative in your area, or write for details?

DeZURIK CORPORATION
SARTELL, MINNESOTA

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$$Zr + 4HCl \rightarrow ZrCl_4 + 2H_2$$
$$U + 3F_2 \rightarrow UF_6$$

. . . and it wouldn't be possible without the Purolator filter that helps cut nuclear fuel reprocessing time from 24 hours to 1½

The latest achievement in reducing the prohibitive fuel-cycle costs of nuclear energy is a fluidized bed halogenation process that provides clean separation of uranium from a zirconium-uranium fuel element. This new process, a big improvement on conventional gas phase volatility processes, was developed at Brookhaven National Laboratory. It would not be operable without two Purolator developments: an Inconel metal-edge distributor plate, A, which is faced on both sides with porous metal; and an Inconel frameless metal edge filter, B, which is faced on the outside with porous metal.

The principal advantage of the fluidized bed technique is its speed in recovering uranium from spent fuel elements. The standard gas phase process takes 24 hours; with a fluidized bed, recovery time is cut to 1½ hours, and the reaction is more uniform and more easily controlled, too.

To operate the Brookhaven pilot plant, a 10" section of spent fuel element is submerged in a mass of inert granular material that is suspended in a mobile, or fluidized, state, by introducing hydrogen chloride gas at suitable velocity at the bottom of the reactor vessel. The Purolator-designed diffuser plate assures complete dispersion of the HCl through the granular bed. Inconel, a porous metal, is used to face the top and bottom surfaces of the plate, to resist the corrosion and the reaction temperature of the fluidized bed, which ranges from 400-450°C.

By creating a reaction in a fluidized bed, coefficients of heat transfer as high as 400 Btu/Hr x Ft² x °F have been observed, with corresponding reaction rates up to 6000 mg per cm²/hr, much higher than could be achieved if gas were the sole coolant. The upward velocity of the gas required to sustain the bed in a fluidized state tends to raise minute particles of uranium above the bed. The metal-edge Purolator filter effectively screens these particles to prevent their loss. The filter that Purolator designed for the Brookhaven installation is composed of a continuous Inconel spiral with integral risers, coated with a thin facing of Inconel which ensures an average filtration of 1 micron.

Performance to date has been so successful that the Brookhaven team plans to build a pilot plant halogenator to conduct complete hydrochlorination and fluorination reactions on full-scale fuel elements. The full-scale production unit will incorporate six Purolator Inconel filters. In addition, because of its corrosion resistance, Inconel will be used as construction material for the halogenator vessel, instead of the present stainless steel.

Presumably you don't have the problem we've just described, but it is a good case in point that Purolator can filter anything that flows. And if your problem (whatever it is) could conceivably involve a filter or a separator, Purolator can help you. Our address: Purolator Products, Inc., Dept. 2683, Rahway, New Jersey.

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For more information, circle No. 149 ▶



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Trufin is produced in many types, sizes, and fin spacings – and in steel, copper, copper alloys and aluminum.

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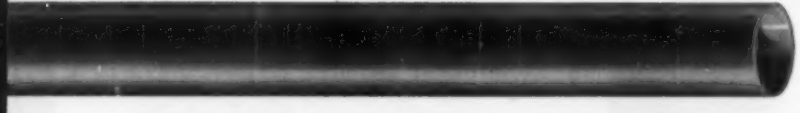
Only Wolverine Tube Division of Calumet & Hecla, Inc. can supply you with such a complete line of integrally finned tube – seven different types designed to bring increased efficiency to a wide variety of heat transfer applications. Each type is available in a complete range of sizes and alloys. Ask your Wolverine salesman for information about how these outstanding tubes can help you.

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. . . AND, OF COURSE, WOLVERINE TUBE also manufactures a complete line of copper, copper alloy and aluminum prime surface condenser tube. Ask your Wolverine sales representative about Wolverine's complete line of products and services.

Wolverine Tube is also a prime mill source for palletized U-bend condenser tubes – manufactures them to your "specs" and ships them to you in disposable box-type pallets so that you can feed directly from pallet to condenser.

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One of a series

The Case for the Terrestrial Traveler

Figure that every thirteen seconds American drivers motor 238,000 miles – the distance to the moon. Increasing the efficiency, comfort, and safety of this incredible private transportation system (60 million cars!) is a top project goal of the General Motors Research Laboratories. From this sizable R & D program have already come a number of experimental controls and driver aids now being evaluated in the field.

New ways of supplying drivers with traffic and road information – electronic edge-of-road detectors; communication systems for giving drivers audible road and emergency information.

Simplified driver controls – Unicontrol, a servo system in which the driver steers, accelerates, and brakes his car with a single control stick.

Tested methods of automatic vehicle control – refined computers and electro-hydraulic servomechanisms that automatically guide cars and control their speed and spacing.

Underlying these developments are a continuing series of fundamental studies. In vehicle dynamics research: investigations of the effect of tire properties, suspension geometry, mass distribution, springs and dampers on the ride and handling characteristics of cars. In human factors research: experiments to determine the perception and response of drivers to various traffic situations using different car control systems.

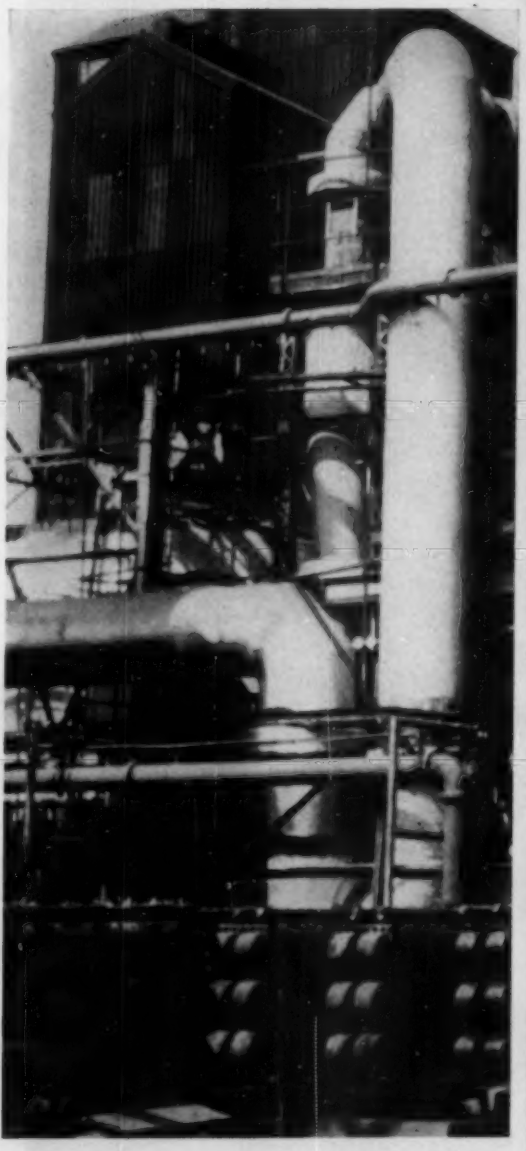
At GM Research, we believe such fresh approaches will improve car-driver compatibility, providing additional convenience and enjoyment for tomorrow's terrestrial traveler.

General Motors Research Laboratories

Warren, Michigan

Car pickup coils and road wiring used for guidance and speed control in one experimental automatic highway system under study.

For more information, turn to Data Service card, circle No. 27



first ***ferrous sulfate decomposition*** *plant in the United Kingdom uses...*

DORRCO® FLUOSOLIDS® SYSTEM

For precise, controlled roasting...

Once again, the versatility of the Dorrco FluoSolids System for roasting has been demonstrated at the new ferrous sulfate plant of British Titan Products Company, Ltd., Grimsby, England . . . the first plant of its kind in the U. K.

The prime contractor was Chemico; equipment and engineering for the roasting step were handled by Dorr-Oliver Company Ltd., Croydon, Surrey.

Copperas arises as a by-product in the extraction of titanium dioxide from ilmenite. In a process developed by British Titan, the copperas is converted to a dry monohydrate powder, by spray drying.

Mixed with pulverized coal or pyrites, the monohydrate is then injected into a fluid bed where it is decomposed to SO_2 gas and iron oxides.

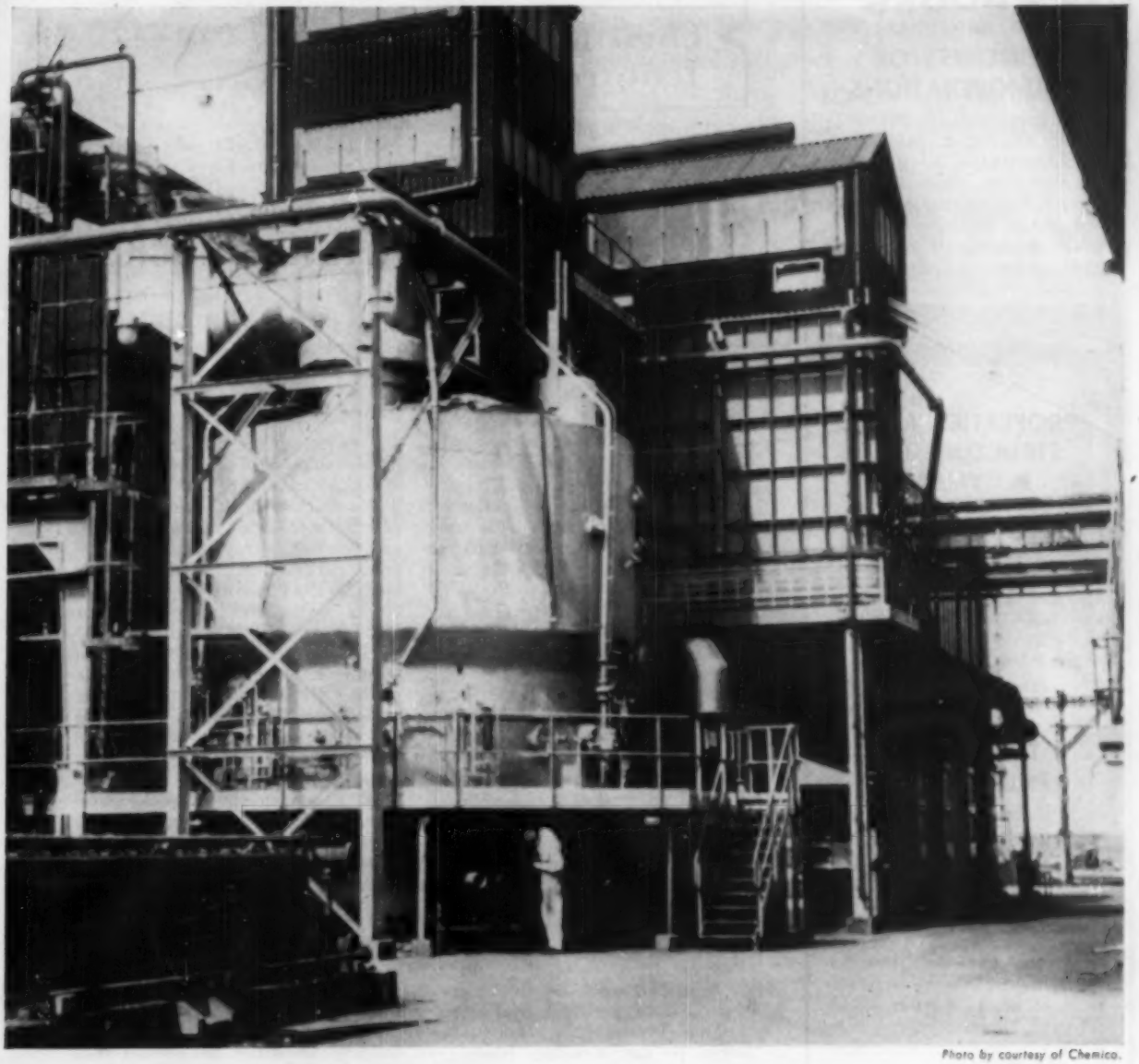


Photo by courtesy of Chemico.

The gases, on leaving the FluoSolids reactors, pass through a waste heat boiler and then on to a Chemico purification and contact acid plant to produce up to 60 tons of acid per reactor, daily. The calcine, relatively pure iron oxide, averaging 1.25% residual sulphur, can be readily sintered for use in steel making.

An alternative process, especially applicable to the treatment of steel plate pickling liquors, decomposes a wet monohydrate cake, obtained from a submerged combustion system, by first drying the cake with waste heat gases. The system offers a larger yield in acid recovery, and lower fuel costs.

For further information on the Dorrco FluoSolids System, please write to Dorr-Oliver Incorporated, Stamford, Connecticut.

What is the FluoSolids System?

A valuable tool for the process industries. When particles are suspended in an upwardly moving stream of gas, the entire dense mass behaves much like a liquid and is said to be fluidized. Applied in the Dorrco fluid bed reactor, fluidization results in a new and more efficient roasting technique, in which each particle of material is individually surrounded by a film of air or gas supplied by an external blower. A combination of reactor, blower, cyclones and other auxiliary equipment forms a complete processing system adaptable to a wide range of applications.

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Wiley BOOKS

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By A. S. FOUST, L. A. WENZEL, C. W. CLUMP, L. MAUS, *and* L. B. ANDERSEN, *all of Lehigh University.* A fresh approach, showing unit operations as unified groups stemming from the same fundamentals. Developments are built up from simplified physical or mathematical models, thence to more complex, realistic problems, applying the general equations to specific operations. *1960. 578 pages. $15.00.*

PROPERTIES AND STRUCTURE OF POLYMERS

By ARTHUR V. TOBOLSKY, *Princeton University.* Reduces seemingly complex physical properties of polymers to easily understood generalizations. Shows also how mechanical behavior can be used to solve problems in polymer chemistry, often otherwise unsolvable. *1960. 331 pages. $14.50.*

TRANSPORT PHENOMENA

By R. B. BIRD, W. E. STEWART, *and* E. N. LIGHTFOOT, *all at the University of Wisconsin.* Treats transport phenomena as a distinct subject in engineering science. Gives parallel coverage to three analogous processes: momentum transport (flow of viscous fluids); energy transport (flow of heat); mass transport (flow of chemical mixtures in species). *1960. Approx. 816 pages. Prob. $13.75.*

PHYSICAL METALLURGY

By B. CHALMERS, *Harvard University.* Uses the scientific rather than empirical approach, building a comprehensive physical framework and examining its validity by comparison with experiment and experience. *1959. 468 pages. $12.50.*

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For more information, circle No. 101

chemical feature

Carbon black growth unchecked

New oil-furnace blacks promise to duplicate or exceed performance of gas semi-reinforcing and premium channel blacks

THE LAST DECADE or so has seen a revolution in the manufacture of carbon black. Prior to 1945, almost the only process for production of fully-reinforcing blacks was the contact or channel process in which the product is collected by impingement of natural gas flames on strategically-located cool metal surfaces, usually standard channel irons, whence the name "channel black." In those days, the only raw material for this class of carbon blacks was natural gas; the industry was largely centered in Texas.

The oil furnace process, which now probably accounts for some 75-80% of world production, was introduced in 1943, and at once started its rapid climb to its present commanding position. Three factors are said to have influenced the fast shift-over to the new oil-furnace method. First, large-scale construction of natural gas pipe lines, which allowed its use in cities far from its point of origin, led to a spectacular rise in the price of the natural gas itself. Second, use of liquid hydrocarbons, easily transported to any distance, freed the industry from the geographical limitations imposed by naturally-occuring sources of natural gas. Thirdly, and perhaps most decisive, the oil-based blacks were found, in many cases, to have superior reinforcing properties over the channel product.

A corrolary result of these developments has been location of oil-furnace plants in Europe and other parts of the world, sometimes far from hydrocarbon sources. Whereas, fifteen years ago, some 90% of the world supply of carbon black came from the U.S., today many nations are partly or wholly self-sufficient.

Oil furnace process

The typical oil furnace plant is made up of three main operating units: the furnace proper; a cooling and collecting section; and pelletizing and shipping. Furnaces are usually of cylindrical form, and are lined with refractory brick. Feed is generally by atomization under pressure, and heating by natural or manufactured gas. Production of the carbon black involves only partial combustion of the feed material; various grades of oil-furnace black can therefore be turned out by varying the combustion conditions. Small particle size in the product, for instance, can be achieved by increasing the amount of air fed into the furnace.

The carbon and the spent gases which leave the furnace at 2,600-2,800°F are generally cooled by water sprays to about 500°F, after which the carbon black product is collected by electrostatic precipitation or bag filters.

New developments

Most recent development in the production of oil-furnace blacks is the announcement by Godfrey L. Cabot, world's largest carbon black producer, of a "new family" in this category. Details of the process used have not been disclosed. First three members of Cabot's new family have been christened Regal 300, Regal 600, and Regal SRF.

Regal 300, according to Cabot, is intended as a lower cost replacement for channel black in rubber applications. It is said to have properties similar to those of a premium-priced channel, but with a faster curing rate, approaching that of an HAF (high abrasion furnace) black. Good dispersions are claimed using normal mixing procedures with commercial polymers having higher viscosity or more elastic "nerve", such as natural rubber, Neoprene, nitrile rubber, and oil-free SBR.

Regal 600 is recommended by the maker for low hardness, passenger tire treads, and for tread rubber with

the resistance of an ISAF (intermediate superior-abrasion furnace) black. Good dispersions have been obtained in natural rubber compounds with normal mixing procedures. Dispersion in oil-extended SBR with normal mixing was unsatisfactory, apparently "as a result of the lower shearing forces encountered." Incorporation in a latex-oil-black SBR masterbatch, however, gave excellent dispersions.

Regal SRF falls near the particle size and surface area range of a gas SRF (semi-reinforcing) black, and is similar to the gas SRF in its degree and strength of pellet aggregation.

Applications

Although way over 90% of total carbon black production is earmarked for the rubber industry, chiefly for tires, several other applications consume respectable quantities. Here again, the trend in recent years has been replacement of the traditional channel blacks by various varieties of oil-furnace blacks.

Second largest users are the printing ink and coating industries, where U. S. consumption is now somewhere in the neighborhood of 80 million pounds annually. Big swing in newspaper inks has been from the cheaper grades of channel blacks to unpelleted rubber-reinforcing grades of oil-furnace blacks. Inks made from these oil-furnace blacks are said to be satisfactory from the point of view of the "jetness" of the print, even though slightly grayer than channel grades previously employed.

For high-quality lithographic inks, however, it is necessary to use about three times as much carbon black as for the lower-priced news inks. In order for these inks to remain fluid, the carbon black used must contain a high percentage of volatile material. For this reason, most lithographic inks still require high grade channel blacks.

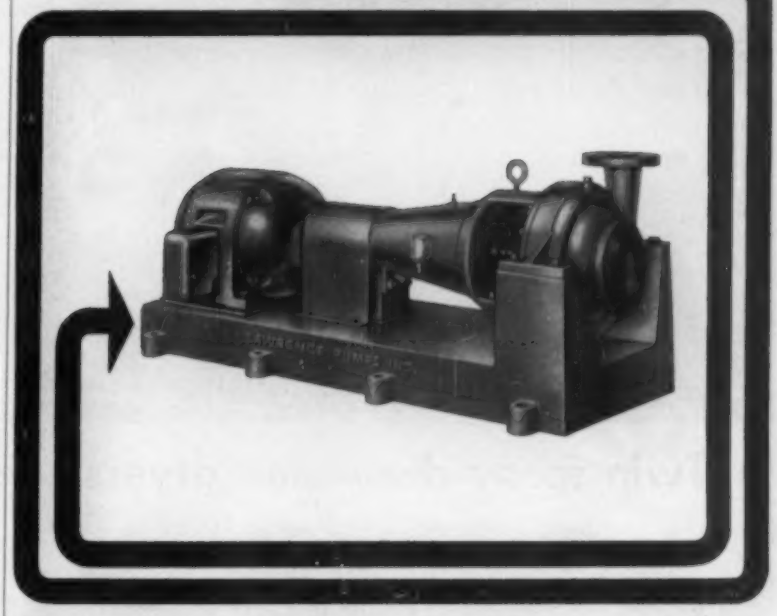
Pigments for the paint and varnish industry are also still largely based on the channel process, except for undercoat paints where jetness of the finish is less important. However, this field may soon be invaded by new high-quality oil-furnace blacks.

Polyethylene additive

Low concentrations of carbon black have been found to increase more than twenty times the resistance of polyethylene to the degrading effects of exposure to sunlight. Percentages used in this increasing application range from 2 to 4% of carbon black. Oil-furnace blacks with a particle size range of 170-200 Å have been found eminently suitable for this use. #

If it's pumpable . . . this process pump can handle it! Here — for the chemical and process industries — is a truly notable achievement in pump design . . . a process pump capable of handling any pumpable fluid — corrosive, hot (1000°F) or cold (—350°F).

This pump can handle anything pumpable because it has virtually everything in the way of features to solve even the toughest pumping problems encountered in the chemical and process industries.



Spacer coupling — to permit removal of impeller, shaft and bearings without disturbing either motor or piping.

Centerline support — to prevent misalignment in handling high temperature liquids.

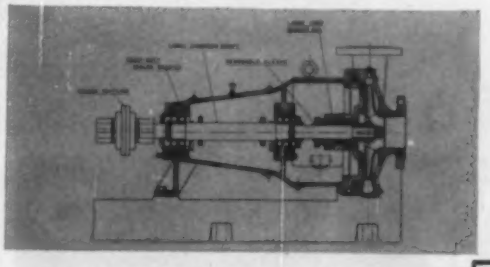
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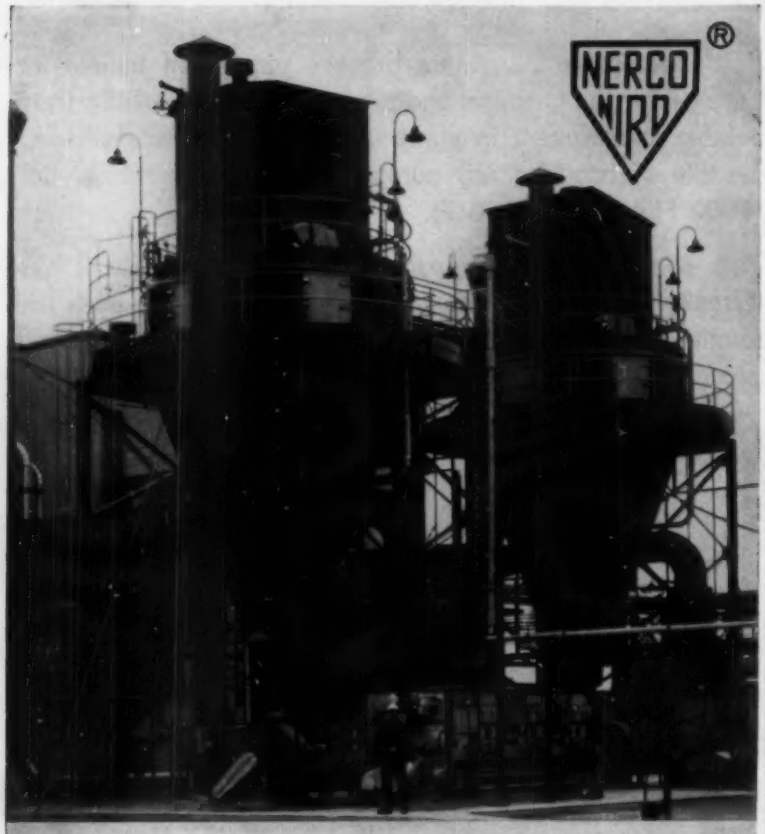


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Whatever your pumping problem, we can save you time and money. Write us the pertinent details. No obligation, of course.

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Twin spray-dispersion dryers at DOW process wet cake

For their new plant in Michigan, The Dow Chemical Company required a gentle process with high thermal efficiency for drying of a heat sensitive plastic from a wet cake to a free flowing powder.

NERCO-NIRO provided the answer by applying the principles of "Gentle-ized" spray drying to the dispersion drying process. The two spray-dispersion dryers pictured above are equipped with atomizers of a novel design, which permit feeding of an unconditioned wet cake. The heat sensitive plastic is gently dried to a final moisture content less than 1/10%, without recycling. No subsequent grinding or screening is required.

Although this heat sensitive material requires low outlet air temperatures, NERCO-NIRO "Gentle-ized" Spray-Dispersion Drying permits inlet air temperatures as high at 500°F, producing a product of unusually high quality at excellent thermal efficiency.

If you are interested in efficient drying of heat sensitive products, be it wet cakes, slurries, emulsions or solutions, NERCO-NIRO's engineering experience and ingenuity, with its research and testing facilities, is ready to assist you.

Nerco-Niro Spray Dryer Div

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For more information, turn to Data Service card, circle No. 53

industrial news

Major synthetic rubber venture

Stauffer, American Synthetic Rubber, form joint company to produce polybutadiene and polyisoprene rubbers at Louisville, Ky.

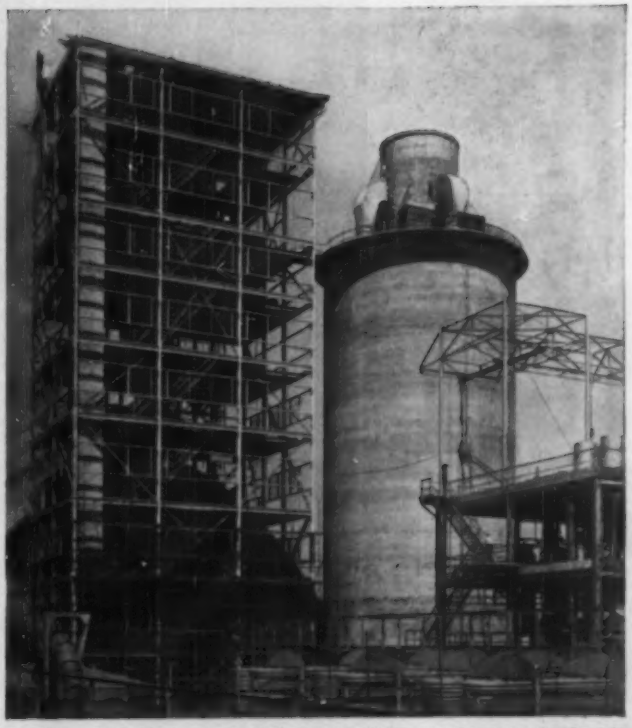
INITIAL CAPACITY OF 30,000 LONG tons per year of polybutadiene and polyisoprene rubbers is scheduled at a new plant to be built in Louisville, Ky., by American Rubber and Chemical Co., newly-formed as a joint venture by Stauffer Chemical and American Synthetic Rubber. The parent companies each own 50% of the new corporation. Stauffer's engineering department will be responsble for construction of the plant, slated for completion in September, 1961. American Synthetic will manage commercial production and marketing. Both Stauffer and American Synthetic will contribute to staff the pilot plant and research laboratories which will form part of the Louisville project.

Amercan Synthetic Rubber was formed in 1955 to buy the government-owned styrene-butadiene copolymer facilities at Louisville. It is owned by twenty-eight companies, most of which are small-to-medium-sized rubber companies producing non-tire rubber products. At least part of the new production, however, will be aimed directly at the tire market. Tests are said to have shown that passenger car tires formulated of 90% polybutadiene and 10% natural rubber were more than 25% superior to SBR-1500 in abrasion resistance; tires of 75% polybutadiene and 25% natural rubber were more than 15% better.

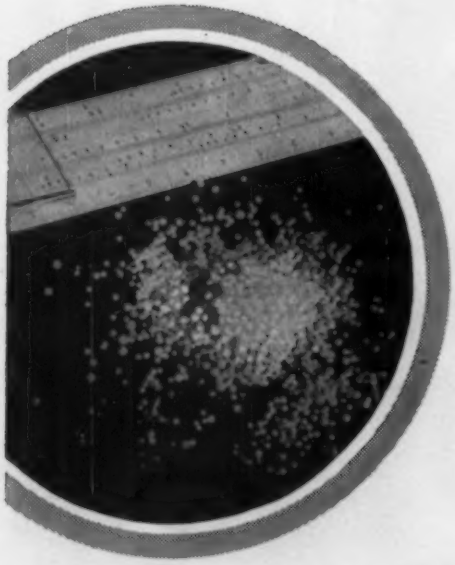
The processes to be used at the new Louisville facilities have been licensed from Phillips Petroleum.

An expansion in catalytic cracking facilities of the Sacor refinery near Lisbon, Portugal, will mean increase in output of liquefied propane and butane from original plant capacity of 24,000 bbl./day. The LPG output is used to supplement the city of Lisbon's manufactured gas supply, and also as bottled gas for cooking and heating purposes in areas where city gas is not available. Hydrocarbon Research has been awarded a contract for engineering and construction of the expansion. Scheduled completion date is early 1961.

Urea plant at Modderfontein, South Africa, during erecting



300 tons of Urea per day



This high capacity Urea plant is constructed and erected by Werkspoor to the designs of Stamicarbon-Holland. Werkspoor is fully qualified to supply the following plants:

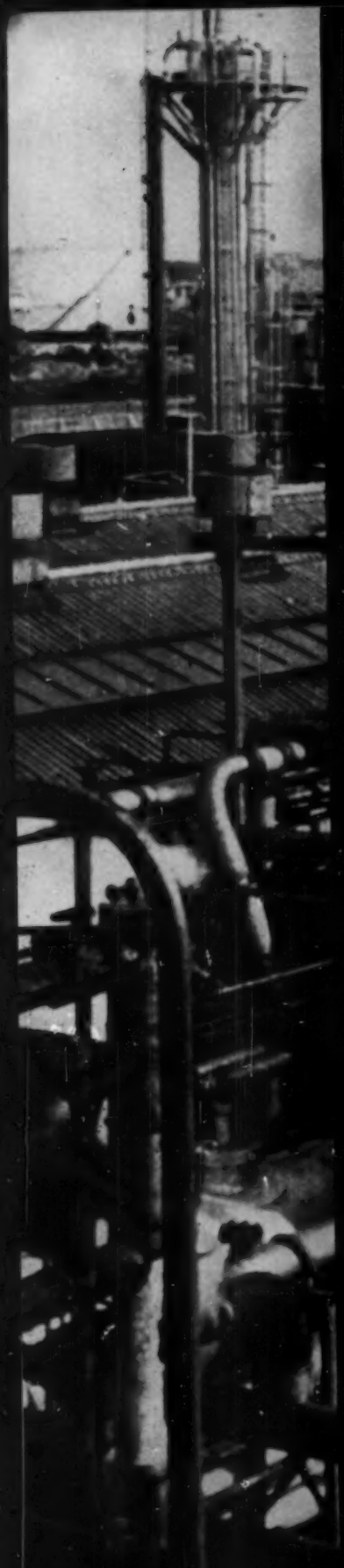
1. Ammonia synthesis (starting from liquid or gaseous fuels)
2. Nitric acid (starting from ammonia)
3. Nitrolimestone (starting from nitric acid, ammonia and limestone)
4. Nitrophosphate (starting from raw phosphate, nitric acid and ammonia)
5. Calcium nitrate (starting from limestone and nitric acid)
6. Sulphate of ammonium (starting from ammonia and sulphuric acid)
7. Urea (starting from liquid ammonia and carbon dioxide)

WERKSPOOR

WORKS AT AMSTERDAM AND UTRECHT

Baudoin

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process dynamics

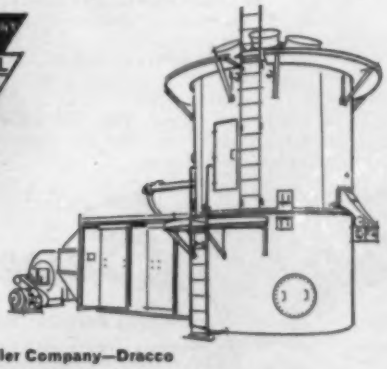
Why settle for equipment when you can buy production?

Big bold concept—process dynamics.
General American's contribution to process dynamics is coordinated equipment. The end result is production.
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General American's wide diversification assures you of the *right* components, properly coordinated right from the start. Extensive General American laboratory and testing facilities enable us to set up pilot operations before you invest one penny.
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Dann Goodson, *Manager Motor-Driven Compressor Sales, The Cooper-Bessemer Corporation, explains...*

How Cooper-Bessemer's new, compact Air Compressors simplify installation and reduce costs

The DMR compressors shown here are two models of a new line of *compact, 720 rpm* machines, unmatched in reliability. With these units, Cooper-Bessemer introduces a new standard of installation economy. So highly compact, the DMR compressors are readily installed in existing space, avoiding the need for additional housing facilities. They can be located at strategic points throughout the plant to supplement existing air line services without additional feeders to help supply your production needs at minimum cost.

The new DMR units come completely equipped with integral motor-drive and intercooler... ready for operation. Their control can also be integrally mounted as shown. They are available for two-stage applications in the range of 500 to 2000 cfm and discharge pressures of 80 to 125 psi... also for single-stage and three-stage operation.



The introduction of this new line of air compressors, plus the portable tool facilities of our new subsidiary, The Rotor Tool Company, enable Cooper-Bessemer to give you full-scope service for your industrial air power needs. Call the nearby Cooper-Bessemer office or air compressor agent for Bulletin No. 94 on the new DMR line.

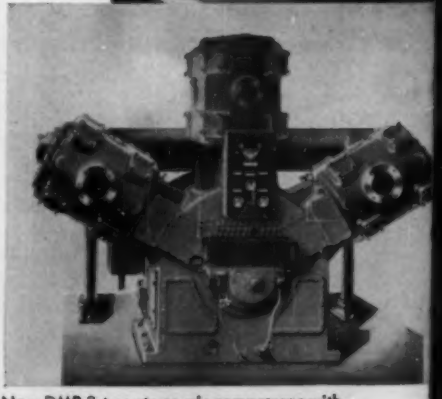
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New DMR-3 two-stage air compressor with integral control. Ratings of 300-350 hp.

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NEW
COOPER-BESSEMER
DMR-2 TWO-STAGE
AIR COMPRESSOR
WITH
EN-TRONIC CONTRO
100 TO 250 HP

industrial focus

E. L. Clark, H. B. Rhodes,
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Linde Co., Div. of Union Carbide.

Sweetening liquid hydrocarbons with molecular sieves

Details of a newly-introduced commercial process. Operating data and cost estimate details show high promise.

The small openings or passageways in Type 13X molecular sieves are 8-9 Å in diameter. Hydrogen sulfide, mercaptans, propane, and other hydrocarbons normally present in natural gas liquids have molecular dimensions sufficiently small so that they will all enter the molecular sieve crystals and be adsorbed. Separation of sulfur compounds from hydrocarbons thus depends on selective adsorption, rather than conventional molecular sieving action, where one component is too large to enter the adsorbent. The polar sulfur compounds are much more strongly adsorbed than the hydrocarbons. Useful bed loadings can therefore be obtained, even when the hydrogen sulfide and mercaptans are present in very low concentrations. For example, from propane at a concentration of only 0.25 grains/100 st. cu. ft., the equilibrium loading is 4.5 lb. H_2S/100 lb. activated adsorbent. An increase in concentration to 100 grains/100 st. cu. ft., raises the loading to 13.5 lb./100 lb.

Equilibrium loadings from n-hexane are somewhat lower; this is caused by differences in the strength of the adsorptive forces between the hydrocarbons and the molecular sieve adsorbent. The larger n-hexane molecules are more strongly adsorbed than the propane and compete more effectively with the hydrogen sulfide for the available sites on the adsorbent. Net result is a higher loading of hexane and a lower loading of hydrogen sulfide.

In addition to hydrogen sulfide, methyl and ethyl mercaptan frequently occur in appreciable concentrations in natural gas liquids. Methyl mercaptan in the liquid phase has adsorption characteristics very close to those of hydrogen sulfide. For cases where a variety of hydrocarbons and sulfur compounds are present simultaneously, an accurate determination of equilibrium loading requires a stepwise calculation with the adsorber bed divided into a number of zones.

Carbon dioxode is also frequently present in the propane stream from natural gas treating plants. The concentration generally depends on the quantity of ethane that is cut into the propane. It ranges from about 0.4-0.5 grains/100 st. cu. ft. in 210 lb./sq. in. vapor pressure propane to essentially zero in a 165 lb./sq. in. stream. The effect of carbon dioxide on the sulfur

continued on page 134

Table 1. Commercial plant results—liquid propane sweetening.

Adsorbent Data		**Feed (mol-%)**	
Two beds at 750 lb. each		Ethane	8
1 ft. 8 in. I.D. x 8 ft.		Propane	91
Type 13X Molecular Sieve		Butane	1
1/16-in. pellets		Hydrogen Sulfide	0.18 grains per 100 st. cu. ft.
		Carbon Dioxide	0.4 grains per 100 st. cu. ft.
Operating Conditions			
Adsorption			
Pressure	– 210 lb./sq. in. gauge		
Temperature	– Ambient		
Time	– 16 hours		
Feed rate	– 85 gal./min.		
Effluent	– Passes copper strip test		
Depressurization			
210 to 120 lb./sq. in. gauge in 15 min.			
Material to fuel.			
Desorption			
Pressure	– 120 lb./sq. in. gauge		
Temperature	– 400°F.		
Time	– 4 hours (1.5 hr. heatup, 2.5 hr. at temp.)		
Rate	– 50,000 (st. cu. ft.)/(hr.)		
Purge	– Absorber residue gas (~99% CH_4, dry, sweet, trace of heavy hydrocarbons)		
Cooling			
~175 gallons of sweet propane			
Time	– 30-60 min.		

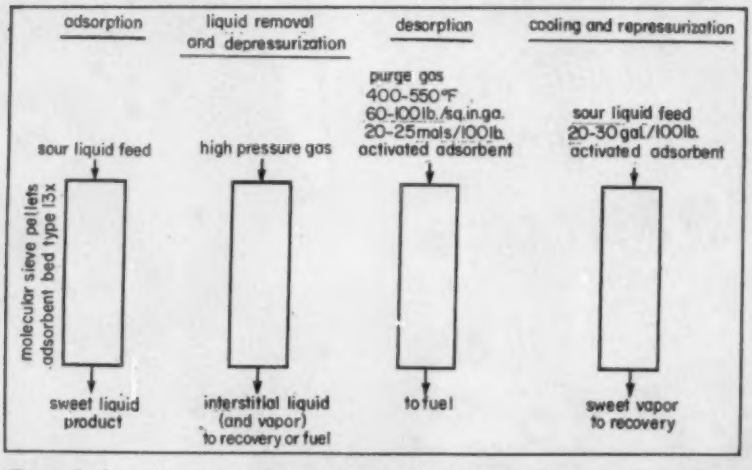


Figure 1. Operating steps—molecular sieve liquid sweetening process.

By 1970 you'll appreciate the lasting value of your 1960 investment in **Bird Continuous Solid Bowl Centrifugals**



Here's why we can say this and make it stick:

After 28 years a producer of southern clays retired their first Bird. They now have eleven in operation. The veteran unit installed in 1932 had been on the job 24 hours a day right up to this year.

Still turning out a fine salt of satisfactory dryness, after 18 years. Question: Should this Bird be repaired or replaced? Answer: Fix it up and it'll be good for many more years of faithful service.

Never opened up for five years. Used for dewatering the lime in a water softening plant, the user writes: "Since the unit has not been opened since it was installed five years ago, it may be time to have a look inside and see if anything needs to be done."

"Another Bird that has been running 24 hours a day since 1940 without mechanical attention." So runs the report from a leading producer of inorganic chemicals, and it continues, "Even so, the repairs are quite minor."

A billion pounds of salt from caustic is the record of a Bird that has been on the job twenty hours a day for the past 8400 days (23 years). Only routine annual check-ups have been required.

These are the kind of service records that can be achieved when corrosion or abrasion do not present serious problems. Even when these are factors, Birds outlast and outperform other separating equipment.

GET THE FACTS, by all means, on comparative dryness of solids, clarity of filtrates, capacity and cost per ton. **The Bird Research and Development Center** stands ready to supply the figures based on pilot-scale tests of your own feed slurries. But keep in mind that Birds are built for the long pull — an investment that brings returns year after year after year.

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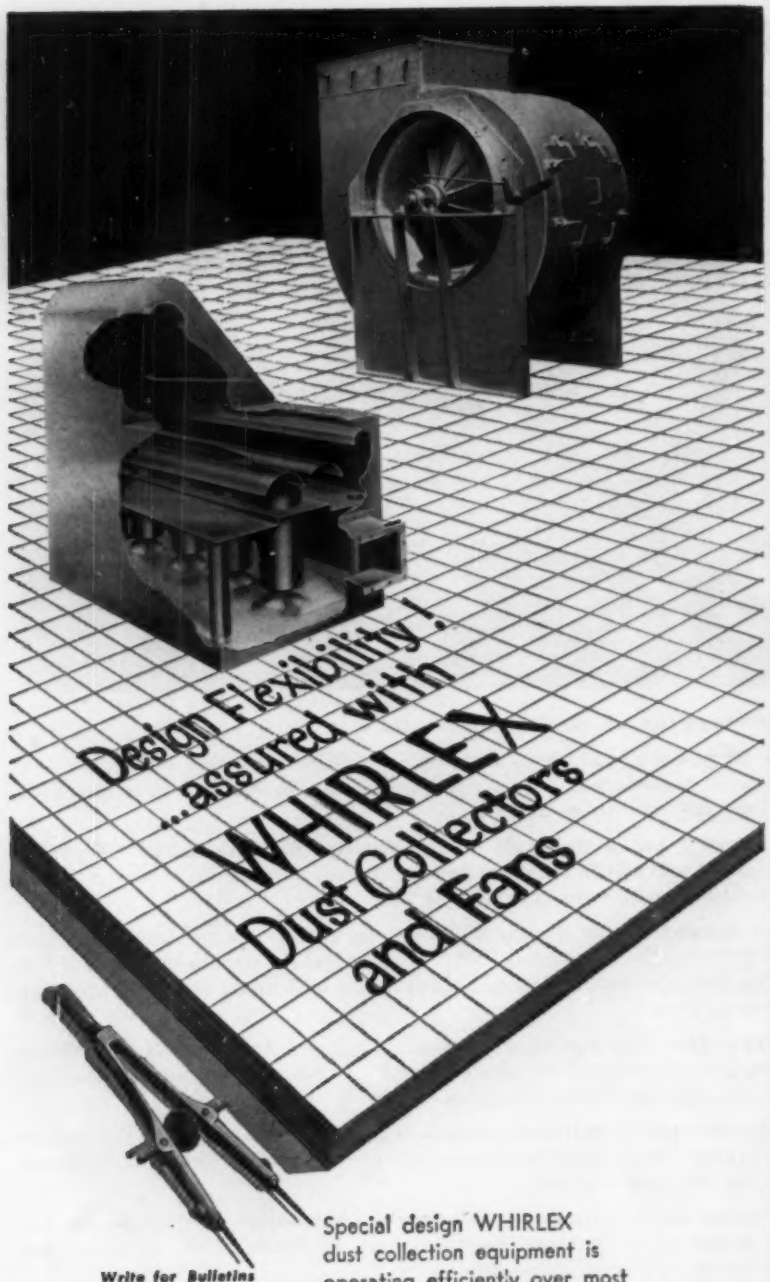
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For more information, turn to Data Service card, circle No. 107

Molecular sieves

from page 132

compound loadings is relatively minor, amounting to only a 5-10% reduction at the higher carbon dioxide contents.

Effect of water

In some cases, the liquid hydrocarbon also contains water. Water is strongly adsorbed on molecular sieves, and will be removed in a short zone at the inlet end of the bed. The weight of adsorbent in this zone must therefore be added to the bed requirements for sulfur removal to obtain the total bed size.

When an adsorbent bed is used to remove sulfur compounds in a commercial process, it is necessary to stop the adsorption when these undesirable compounds appear in the effluent. This leaves a section of the bed towards the effluent end which is only partially loaded to equilibrium. In order to take this partial loading into account, equilibrium values must be multiplied by a factor of 0.02 to 0.8, depending on both the concentration of sulfur compounds in the feed and on the flow rate. The lower value applies to low feed concentrations and high flow rates, while the higher represents high concentrations and low rates.

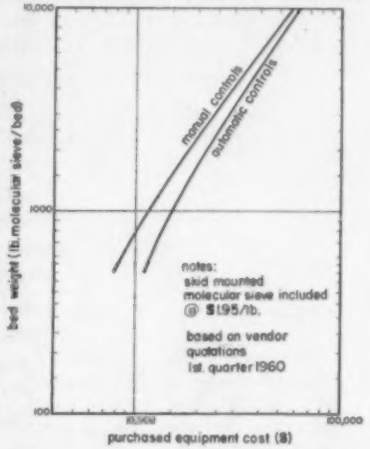


Figure 2. Estimated purchased equipment costs—molecular sieve liquid sweetening units.

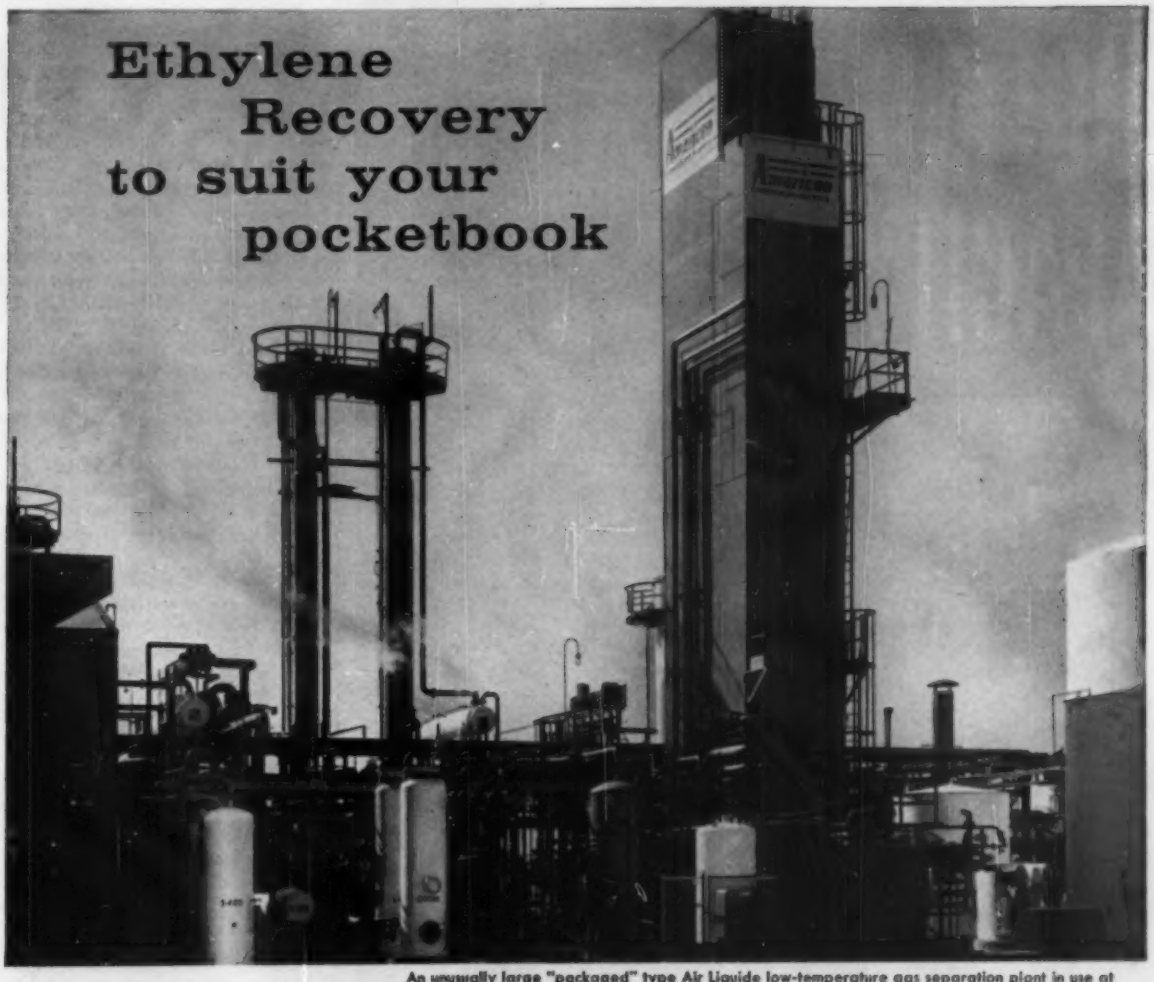
Process operation

The four basic steps in the process are shown diagrammatically in Figure 1.

• **Adsorption:** At the start of this step, the bed is at ambient temperature and is full of liquid hydrocarbon. The pressure is sufficiently high to keep vapor pockets from developing. Sour feed passes downward through the bed, the sulfur compounds are

continued on page 136

Ethylene Recovery to suit your pocketbook



An unusually large "packaged" type Air Liquide low-temperature gas separation plant in use at American Chemical Corporation's chlorinated-hydrocarbon manufacturing centre in California.

Lower capital outlay, elimination of over-production problems, and greater all-round design and operational flexibility. These are some of the positive advantages gained from the use of *low-temperature gas separation* in ethylene recovery.

Low-temperature separation permits the building of smaller units, which result in lower erection and operation costs. Air Liquide designs and builds these smaller units as "pre-packaged" assemblies, with capacities up to 100 tons or more per day.

During the past 30 years, Air Liquide has been recovering ethylene from effluent gases like coke-oven gas (containing 1.5 to 2%) and refinery off-gases (containing 5 to 15%) by the low-temperature process. And Air Liquide has built more ethylene recovery units and hydrocarbon separation plants than anyone in the world.

If you are thinking of ethylene recovery, check first with American Air Liquide.

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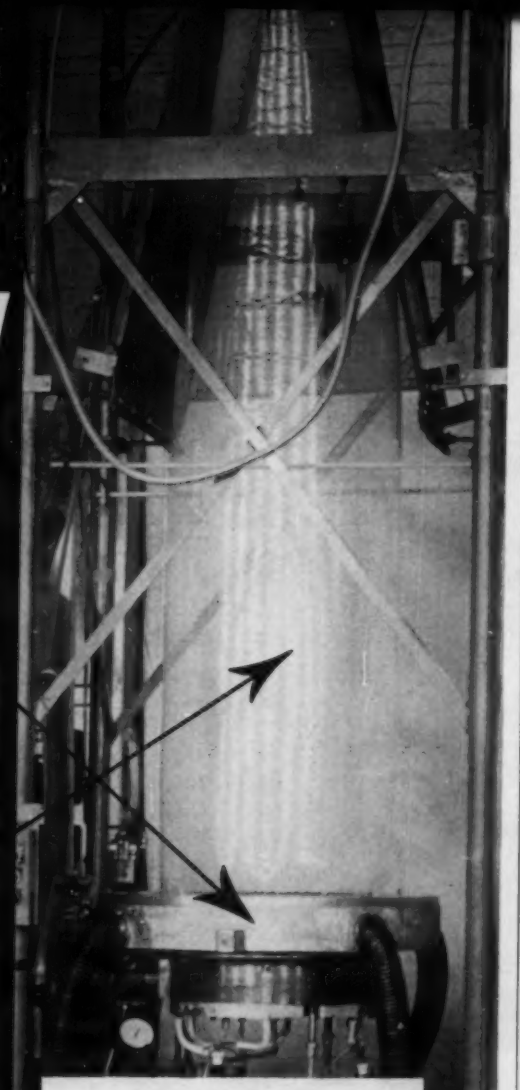
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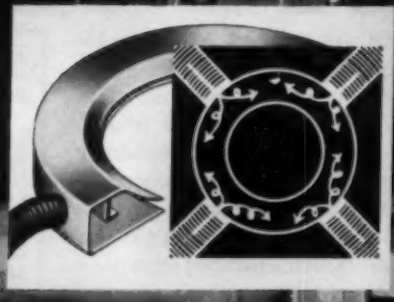
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For more information, circle No. 79

Molecular sieves

from page 134

adsorbed on the molecular sieves, and sweet liquid product is removed continuously from the bottom. Control is maintained to keep the bed full of liquid. Flow is normally stopped after a predetermined time, and before undesirable sulfur compounds appear in the effluent. Feed mass velocities are in the range of 1,500-12,000 lb./(hr.)(sq. ft.).

• **Liquid removal and depressurization:** The interstitial liquid in the bed is next removed, and the pressure is reduced to 60-120 lb./sq. in. gauge. The lower pressures give more effective utilization of the purge gas in the subsequent desorption step. The range is set by the pressure of the fuel header used to dispose of the purge.

In one method of operation, high pressure gas is introduced to the top of the bed to force out the liquid at essentially the feed pressure. The bed pressure is then lowered. Alternatively, the bed may be drained and the pressure reduced in one operation. Vaporized hydrocarbons may be sent to an external condenser, be recycled to a lower stage of compression, or be sent to fuel. In any of these methods, the pressure reduction must be carried out over a period of about 15 minutes. This avoids surging, sudden flash vaporization, and movement of the adsorbent bed.

• **Desorption:** The sulfur compounds are removed from the bed by a hot purge gas. The gas, at 60-120 lb./sq. in. gauge, passes downward through the bed, and then into the plant fuel system.

Bed temperatures of 400-550°F are used. The lower temperature is sufficient for hydrogen sulfide, while the higher is necessary when mercaptans are present. A total of 20-25 mols of gas per 100 lb. of molecular sieves is required. Occasionally, when more gas is available, a larger flow will be used.

The purge gas should be dry, sweet, and contain no oxygen. The latter requirement is particularly important, because any oxygen entering the bed will react with the hydrogen sulfide to deposit sulfur. A typical example of a suitable gas is de-ethanizer overhead.

• **Cooling:** After desorption, the bed is cooled by introduction of liquid feed or liquid product to the top of the bed. When the feed is nearly sweet,

continued on page 140

For more information, circle No. 150

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U.S.I. CHEMICAL NEWS

September ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1960

Coal Tar Naphthalene Is Purified Economically by Continuous Sodium Process

A semi-continuous, commercial process for desulfurizing coal tar naphthalene, through treatment with metallic sodium, has been developed by U.S.I. specialists in sodium chemistry. This development provides coke oven producers with an efficient and economical method for purifying naphthalene to the levels demanded by makers of phthalic anhydride, dyes, vinyl plastics, moth balls and other naphthalene products.

78° Naphthalene can be treated with 1.5% by weight of sodium for reduction of sulfur content from about 0.5% to less than 0.05%, at a cost of under one half a cent per pound. Naphthalene recovery would exceed 99%. Capital investment for a plant to treat 50-60 million lb./yr. of naphthalene would be about $50,000.

In such a semi-continuous plant naphthalene—with residual phenols removed through pretreatment with solid caustic for best sodium efficiency—is fed into a series of kettles and contacted with sodium for 30-60 minutes. The naphthalene is then flash distilled from the residue. The residue, upon decomposition with steam, yields crude napthalene, low in sulfur, which would be returned to the head of the process.

Bulk sodium is metered directly into the treating kettles. With adequate agitation, sodium will emulsify quickly and

MORE

New Trona Mining Method Planned in Intermountain's Soda Ash Plant Expansion

Intermountain Chemical Co., a 10% owned affiliate of U.S.I., has announced plans for a $4,000,000 expansion of their soda ash facilities, to be completed in 1962. Capacity is being increased from 520,000 to 720,000 tons per year.

The company mines trona ore in the Green River area of southwestern Wyoming and refines the ore into soda ash. A new method for mining trona, developed by Intermountain, will be tried for the first time as part of the expansion. It is a continuous system for mining, extraction and movement of trona which eliminates blasting and drilling underground. The method uses augers, adapted from hard-coal mining.

During expansion, Intermountain will also make changes in refinery technology.

Final Regulations on Tax-Free And SD Alcohols Now in Effect

A&TTD Issues New Simplified & Liberalized "User" Regulations

The Alcohol and Tobacco Tax Division of Internal Revenue published final revised regulations (effective July 1) on the distribution and use of Specially Denatured and Tax-Free Alcohols in the Federal Register of June 29. These regulations provide for administration of the Internal Revenue Code of 1954 as amended by the Excise Tax Technical Changes Act of 1958.

For the first time, the A&TTD has separated "user" regulations from others covering production of ethyl alcohol and specially denatured formulations. Here is a brief summary of some of the important provisions of the new "user" regulations. For details, see Industry Circulars 60-22 on SDA and 60-21 on Tax-Free.

(1) **Industrial Use Permits**—Forms 1481 (SDA) and 1447 (Tax-Free)—no longer have to be renewed annually. They remain in effect unless suspended, revoked, surrendered or otherwise terminated.

(2) **Withdrawal Permits:**
Form 1485 (SDA)—permits expire Oct. 31 each year. Renewal application must be filed annually by July 10, Effective Nov. 1, 1961, permits will allow monthly withdrawal of 1/8 of annual allowance (formerly 1/12).
Form 1450 (Tax-Free)—permits expire Apr. 30 each year. Renewal application must be filed annually by Jan. 10. Effective May 1, 1961 (earlier with special permission), permits will allow monthly withdrawal of 1/8 of annual allowance (formerly 1/12).

(3) **Losses**—on SDA, the minimum quantity on which a claim for re-

MORE

New Polyethylene Bag with No-Leak Closure Shows Promise as Sterile Pack

A new, low-cost, sterile polyethylene bag with a wire tape closure is now being used by the dairy industry for milk sampling and reportedly finding application in a number of fields, including cosmetics. The containers are made of clear, heavy polyethylene tubing, sealed both top and bottom to keep the inside sterile.

A line of perforations is provided for removing the sealed top. Below the perforations are two wire tapes which help in opening and form the closure for the bag. For resealing, tapes are pulled taut, top of bag is rolled down, and projecting ends of tapes are bent over. A liquid-tight closure is formed. The three photos below show unsealing, opening and resealing.



New polyethylene bag is sterile-sealed until perforated top is zipped off.



Bag is snapped open by pressing in on wire tapes around top opening.



Liquid-tight resealing is done by rolling bag top down, and folding tape ends over.

September ★ **U.S.I. CHEMICAL NEWS** ★ 1960

CONTINUED *Alcohols*

mission of tax must be filed has been increased to 5 wine gallons. On Tax-Free, the minimum quantity has been increased to 5 proof gallons.

(4) **Reports:**
Form 1482 (SDA)—submitted annually instead of monthly for users who withdraw less than 660 gal./yr. Those who withdraw more must still report monthly, unless otherwise authorized.
Form 1451 (Tax-Free)—submitted annually instead of monthly.

(5) **Samples**—SDA samples of one quart may be obtained without permit.

(6) **Samples of Labels and Advertising** for articles not containing SDA, but made from SDA, no longer required by A&TTD except on request.

(7) **Carrier Permits**—no longer required.

(8) **Proprietary Solvents**—may be packaged by *distributors and users* as well as manufacturers, provided the packages are properly marked.

(9) **Return**—Consent of Surety for return will no longer be required of SDA permittees, but will be required in blanket form from person to whom returned.

Many other points are also covered in detail in Industry Circulars 60-22 and 60-21. It can be seen that the A&TTD has made the new regulations more liberal, and has simplified the paper work involved in the use of SDA and Tax-Free Alcohols.

CONTINUED *Naphthalene*

react. It is not necessary to use predispersed sodium, since crude naphthalene contains many naturally occurring trace impurities which are excellent dispersing aids for sodium.

For further information, send for the new U.S.I. technical data bulletin "Desulfurization of Naphthalene by Sodium". Address Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., N.Y. 16, N.Y.

New Polyethylene Resins Produce Squeeze Bottles Of Excellent Appearance

U.S.I. has developed three new PETROTHENE® polyethylene resins with properties particularly suited to the blow molding of bottles for drugs, cosmetics and chemical specialties. Two of the resins can also be used for injection molding. All have been successfully field tested. Each of the resins produces bottles of outstanding appearance, good stress crack resistance and excellent low temperature flexibility.

PETROTHENE 101 and PETROTHENE 102-2 can be used in both blow molding and injection molding. The first has high stiffness, which permits reduction in wall thickness and, consequently, lower cost per container. The second has high impermeability to liquids, oils and gases, and a high flow rate which is particularly useful in blow molding pieces 6 to 20 oz. or heavier. PETROTHENE 209-2 is designed for use only in blow molding, especially for relatively small moldings—under 10 oz. —with thick side walls.

Data sheets on these three new resins are available from U.S.I. Address Technical Literature Dept., U.S.I. Chemical News, 99 Park Ave., New York 16, N. Y.



First heat exchanger successfully fabricated from zirconium is part of unit to concentrate H_2O_2 solutions. Zirconium's corrosion resistance in this application made it profitable to overcome welding problems associated with the metal. (Photo courtesy The Pfaudler Co.)

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

High molecular weight synthetic polypeptides now commercially available include glutamic acid, γ-benzyl glutamate, lysine hydrobromide, ε-carbobenzoxylysine, ε-carbobenzoxytyrosine, leucine, alanine, phenylalanine, tyrocine. **No. 1630**

New booklet on industrial hazards—casualty, fire, pollution and product liability—discusses measurement, detection, correction and litigation. Stresses prevention, and need for help of experts when mishaps occur. **No. 1631**

Borax and other boron compounds are described in new brochure which can now be obtained. Contents include historical data; production, uses, properties of commercial boron compounds; properties of 28 research chemicals. **No. 1632**

Kit for emergency radioactivity decontamination is now on market. Provides radioisotope users and laboratories with respirator, disposable clothing, decontamination solutions, instruction manual—all in steel case. **No. 1633**

Acetone specifications, properties, shipping methods and uses are listed in new data sheet now available. Material is widely used as solvent, and in making drugs, dyes, plastics and many other organics. **No. 1634**

New polyethylene drum faucet is said to empty 55-gallon drum of average material in about two minutes. Fits standard 2-inch drum outlet. Comes with polyethylene spout closure to eliminate residual dripping. **No. 1635**

Hair care is covered in new book now being sold. Said to be most complete ever written for layman on growth, care, diseases and treatment of hair disorders. **No. 1636**

Non-electric magnets have been installed under belts of conveyors on aerosol filling lines to hold cans in place during underwater travel to heating bath. Magnetic units said to be available in lengths to fit any conveyor belt. **No. 1637**

The rare earths plus thorium, scandium and yttrium—chemicals, metals, alloys—are detailed in new booklet. Gives uses, potentials, production, properties, chemical analyses for over 50 products. **No. 1638**

New, versatile, bench model superspeed centrifuge with built-in safety shield, accommodating 5 interchangeable rotors for batch or continuous flow separations, is on market. Rotors are fitted with removable polyethylene liners. **No. 1639**

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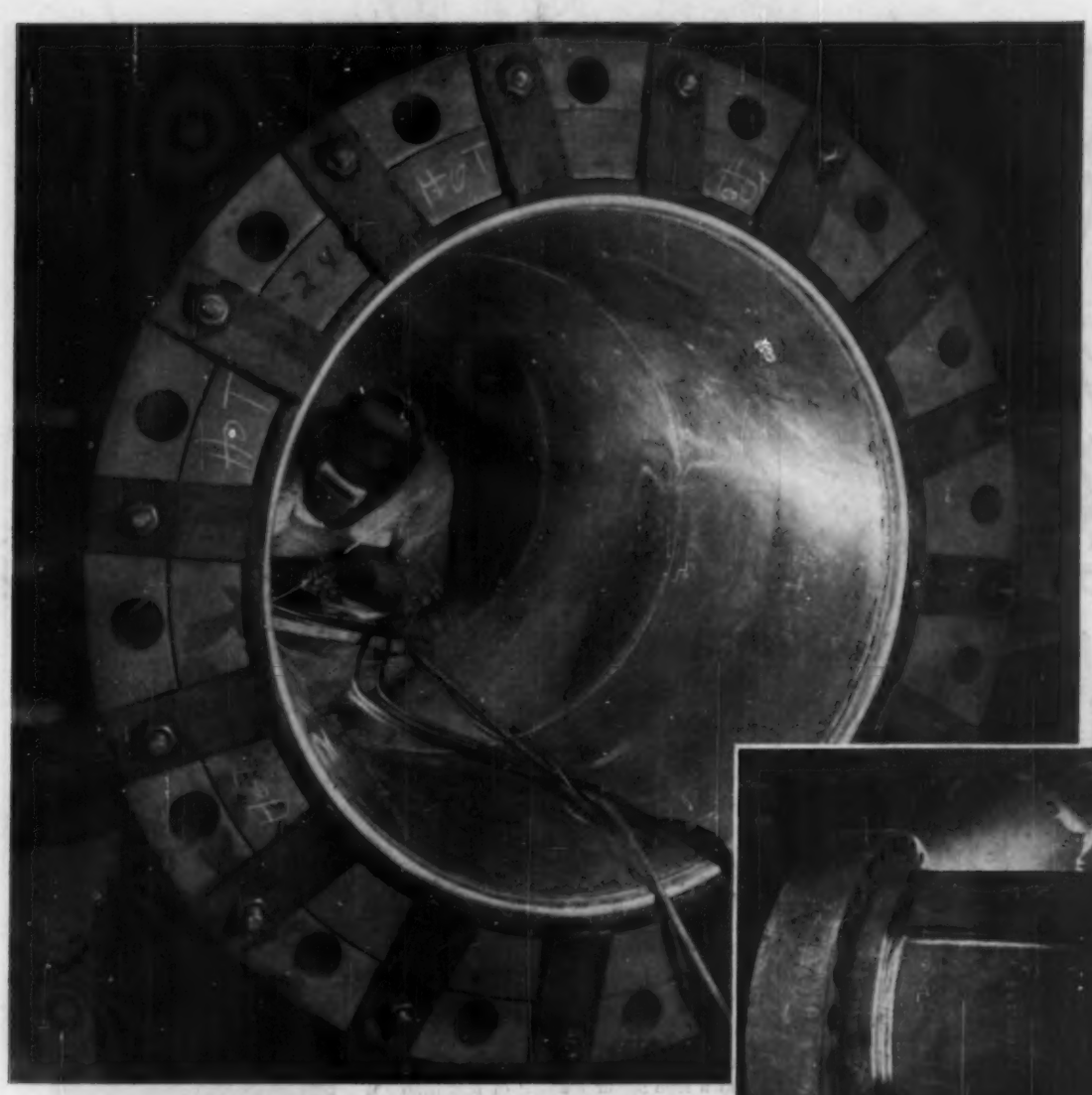
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For more information, circle No. 26

Molecular sieves

from page 136

on the order of 1 grain sulfur per 100 cu. ft., it is normally used. At higher concentrations, sweet product is preferred. Sufficient differential pressure to cause product flow through the tower being cooled can be obtained quite simply by installation of a back pressure regulator. For either cooling stream, the rate of addition must be controlled to prevent surging. A flow of about 4 gallons per minute per square foot of bed cross-section has been found satisfactory. A total input of 20-30 gallons per 100 lb. of molecular sieves is normally required. The vaporized material can be recovered by one of the methods listed previously under depressurization.

Bed arrangement

The four steps outlined are carried out in sequence on two adsorber beds with the timing arranged so that one bed is on adsorption. The desorption period can be varied but in general takes 4-8 hours. The cooling period which follows takes about an hour, so there is frequently a period of time when one bed is on standby.

Commercial operation

Results obtained in a commercial plant operating on the cycle outlined above are summarized in Table 1. After eight months of continuous operation, this bed was still giving 16 hours on stream. At this point, it was opened and showed no loss of molecular sieves. Samples removed had a hydrogen sulfide capacity 90% of that of fresh material, a carbon loading of 2.0 lb./100 lb. of activated adsorbent, and a free sulfur loading of less than 0.02 lb./100 lb. On this basis, a one-year life for the adsorbent appears certain, and a considerably longer life quite probable.

Economics

Estimated purchased equipment cost for skid-mounted molecular sieve liquid sweetening units is shown in Figure 2. These costs are based on quotations by equipment vendors. The majority of installations to date fall around the 2,000 lb./bed size, with a cost of about $20,000.

Main item of operating expense is replacement cost of the adsorbent. This cost can be figured quite simply from the bed size and the adsorbent life. Other charges such as labor, maintenance, and fuel are so small a fraction of those for the overall gas-treating operation that they are normally not even considered. #

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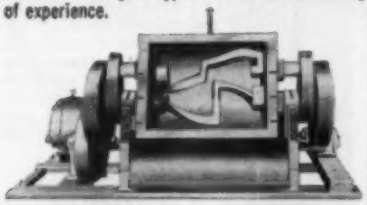
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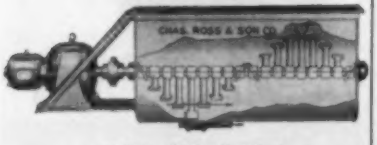
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For more information, circle No. 110

A.I.Ch.E Candidates

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 3 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before October 15, 1960, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

Associate Member

Alker, Paul B., *Newport, R. I.*
Alstad, Allen T., *Billings, Mont.*
Ammons, Richard B., *Marion, S. C.*
Andersson, Craig R., *Swarthmore, Pa.*
Arape, Omar, *Caracas, Venezuela*
Askew, John D., Jr., *Atlanta, Ga.*
Ayala, Lino E., *Caracas, Venezuela*

Baber, Michael F., *Newark, Del.*
Bamford, Charles R., *Belle Glade, Fla.*
Barfield, Billy B., *Wichita Falls, Texas*
Baskerville, R. James, Jr., *Drexel Hill, Pa.*
Baumeister, Louis F., *Los Angeles, Calif.*
Baxter, Harlan M., *Mt. Herman, Mass.*
Beck, Martin, *Quincy, Mass.*
Belnski, Joseph H., *Wyandotte, Mich.*
Benjamin, H. Eugene, *Borger, Texas*
Berkey, Harry A., Jr., *Tulsa, Okla.*
Berney, Peter J., *Houston, Texas*
Bernstein, Leon D., *Elmwood Park, Ill.*
Bigler, Kenneth L., *Lexington, Ohio*
Bishop, Jerry E., *Louisville, Ky.*
Bitler, Lyle H., *Charleston, W. Va.*
Blaich, Leon, *Hazlet N. J.*
Blok, William S., *Grand Island, N. Y.*
Board, William J., Jr., *Decatur, Ala.*
Boggan, Jesse, *Pensacola, Fla.*
Bohrer, Thomas C., *Brooklyn, N. Y.*
Bollenbeck, Peter H., Jr., *Cincinnati, Ohio*
Bolles, Thomas V., *Norwich, Conn.*
Boniface, Arthur, Jr., *Cincinnati, Ohio*
Boyd, Charles W., *Houston, Texas*
Bronfin, Barry R., *Cambridge, Mass.*
Buenz, Peter, *San Antonio, Texas*
Bush, Dale E., *Houghton, Mich.*
Bush, Ronald E., *Cleveland, Ohio*
Byrne, James B., *Woodbury, N. J.*

Caplinger, Wayne H., *Morgantown, W. Va.*
Carroll, Paul W., *Port Neches, Texas*
Cavanaugh, Thomas A., *Roslindale, Mass.*
Chance, Vernon B., Jr., *Shreveport, La.*
Chi, John Wen Hua, *Pittsburgh, Pa.*
Chung, P. C., *New York, N. Y.*
Cicciari, N. Anthony, *Niagara Falls, N. Y.*
Cleveland, Joe R., *Torrance, Calif.*
Cole, Harold E., *Dayton, Ohio*
Cole, James K., *Rensselaer, N. Y.*
Conger, William L., *Louisville, Ky.*
Conte, Frank A., *Allen Park, Mich.*
Cook, Paul A., *Cincinnati, Ohio*
Copeland, William Robert, Jr., *Camden, Ark.*
Cronauer, Donald C., *Pittsburgh, Pa.*
Cuddeback, Richard B., *White Plains, N. Y.*

Damerell, Glenn L., *Minneapolis, Minn.*
Daniel, William E., *Deer Park, Texas*
Davis, Leman M., *Richmond, Calif.*
Deobald, Theodore Lee, *Richland, Wash.*
DePoy, Phil E., *China Lake, Calif.*
Dillon, Glen E., *Concord, Calif.*
Dobie, Dudley R., Jr., *La Porte, Texas*
Doff, Lawrence D., *Mt. Vernon, N. Y.*
Drangel, Irwin, *Schenectady, N. Y.*
Duszik, Andrew G., *Wilbraham, Mass.*

Easter, James D., *Houston, Texas*
Edwards, John W., *Ruston, La.*
El-Rifai, M., *Norman, Okla.*
Erb, Louis P., *Louisville, Ky.*
Etchison, John W., *Gadsden, Ala.*
Ettie, Gordon E., *Gainesville, Fla.*

Fabera, John Wensel, *Sacramento, Calif.*
Farone, Vincent A., *Watervliet, N. Y.*
Faucett, Henry Lewis, *Marietta, Ga.*
Fearing, Watson B., *Richmond, Calif.*
Federovich, John J., *Wilkes-Barre, Pa.*
Felten, Loren D., *Canoga Park, Calif.*
Fisher, Theodore F., *Buffalo, N. Y.*
Fitzjohn, John L., *Newark, Del.*
Fiedderman, Kenneth A., *Akron, Ohio*
Flynn, John J., Jr., *Framingham, Mass.*
Fretwell, Sylvester W., *Pensacola, Fla.*
Friedman, Morton H., *St. Paul, Minn.*
Fritz, Raymond R., *Ponca City, Okla.*
Furukawa, David R., *Denver, Colo.*

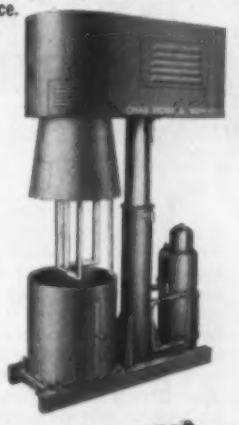
Gaichas, David A., *Chicago, Ill.*
Galloway, Earl W., *Villa Park, Ill.*

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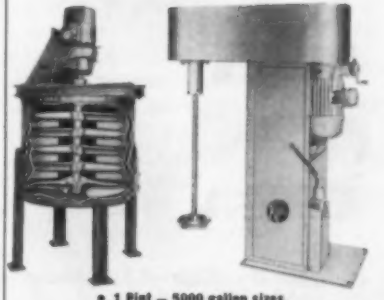
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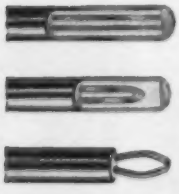
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Gieck, Joseph F., *Prairie Village, Kans.*
Girodo, Joseph L., Jr., *Decatur, Ala.*
Gomide, Reynaldo, *Sao Paulo, Brazil*
Googer, Marcus Dee, III., *Decatur, Ga.*
Grant, Andrew D., *Lyndhurst, N. J.*
Greenman, Thomas E., Jr., *St. Louis, Mo.*
Grifno, John E., *Marshall, Texas*
Griswold, Gary L., *Oakfield, N. Y.*
Grube, Donal T., *Somerset, Ky.*

Hales, Jeremy M., *Bothell, Wash.*
Ham, Donald E., *Knoxville, Tenn.*
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Harvey, Jack B., *Alton, Ill.*
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Hebert, Leon F., *Agawam, Mass.*
Hegarty, William P., *Wilmington, Del.*
Henkin, Phillip K., *Wilmington, Del.*
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Holmes, Curtis L., *La Porte, Ind.*
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Honningford, Joseph B., *Evansville, Ind.*
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Pauplis, William J., *Hudson, Mass.*
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Perkins, Richard T., *Borger, Texas*
Piecuch, Peter J., *Elmira, N. Y.*
Piergrossi, Maurice J., *Wilmington, Del.*
Pietrzkiewicz, Robert John, *Stamford, Conn.*

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Richards, Thomas, *Louisville, Ky.*
Rish, Walter Anthony, Jr., *Acushnet, Mass.*
Roach, Thomas L., *El Dorado, Ark.*
Robertson, Carroll L., *Ft. Sam Houston, Texas*
Rothman, Stephen, *Brooklyn, N. Y.*
Ruckstuhl, Robert W., *White Plains, N. Y.*
Russell, Edward J., *Kenmore, N. Y.*

Saidel, Gerald M., *New Haven, Conn.*
Schlaile, Erich G., *Pasadena, Texas*
Schmidt, George R., *Sacramento, Calif.*
Schnabel, John H., *Spangler, Pa.*
Schof, David E., Jr., *New Orleans, La.*
Schurtz, Gerald D., *Kankakee, Ill.*
Sciance, Tom, *Nashville, Tenn.*
Scott, George Thomas, *Texas City, Texas*
Scrivener, Harry W., *Jacksonville, Fla.*
Seubert, John G., *Crane, Ind.*
Shaleesh, George G., *Brooklyn, N. Y.*
Shelstad, Kenneth A., *Montreal, Canada*
Silvestri, Nathan J. P., *Hanson, Mass.*
Silvey, Franklin C., *Alhambra, Calif.*
Smith, Don, *Udall, Kans.*
Smith, Marcus, *Pensacola, Fla.*
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Smith, Myron H., *Quincy, Mass.*
Sommerville, Robert Franklin, *Louisville, Ky.*
Speer, John S., Jr., *Pasadena, Texas*
Spencer, Dan T., *Canton, N. Y.*
Spieth, Emil E., *Miami, Fla.*
Sprout, William H., *Circleville, Ohio.*
Sterrett, Robert C., *Long Beach, Calif.*
Stewart, Lee R., *Palmerton, Pa.*
Stober, Van K., *Gales Ferry, Conn.*
Stuart, Harold H., *Gholson, Miss.*
Stugard, Charles R., *Cincinnati, Ohio*
Sturrock, Richard H., *Beaumont, Texas*
Svindland, Arne, *Linwood, N. J.*

Taft, Gary, *Brooklyn, N. Y.*
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Thomas, Michael, *Texas City, Texas*
Thompson, H. Brian, *Milton, Mass.*
Thomsen, Evan E., *Salt Lake City, Utah*
Tillotson, Robert W., *Longview, Wash.*
Tom, Wing-Choo, *Philadelphia, Pa.*
Toma, Khalry R., *Detroit, Mich.*
Toth, Robert L., *Allen Park, Mich.*

Uebelacker, Robert J., *Cuyahoga Falls, Ohio*
Ulbrich, Arthur, *Port Arthur, Texas*
Unger, Thomas A., *Sao Paulo, Brazil*

Venuti, Joseph E., *Durham, Conn.*
Verolini, Adolph E., *Bradford, Pa.*

Ward, Gary N., *Boise, Idaho.*
Watson, Marvin, Jr., *Port Neches, Texas*
Wheeler, Robert C., *West Islip, N. Y.*
Whitaker, Ralph A., *Starkville, Miss.*
Wiederkehr, Robert, *Midland, Mich.*
Williams, Wm. Henry, *St. Paul Park, Minn.*
Willis, David A., *Manhattan Beach, Calif.*
Wilson, Alden R., *Texas City, Texas*
Withers, Philip A., *Cincinnati, Ohio*
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Wolkowicz, Richard L., *Vineland, N. J.*
Wood, R. K., *Unity, Sas., Canada*
Wyer, Richard R., *Spokane, Wash.*

Yaeger, John F., *Wyandotte, Mich.*
Yaeger, LeRoy M., *Mansfield, Ohio*
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Aroclor temperature is maintained automatically to within ±2° F. at the heater — regardless of system load. Precise processing temperatures are maintained without elaborate controls. Consistently high product quality is assured.

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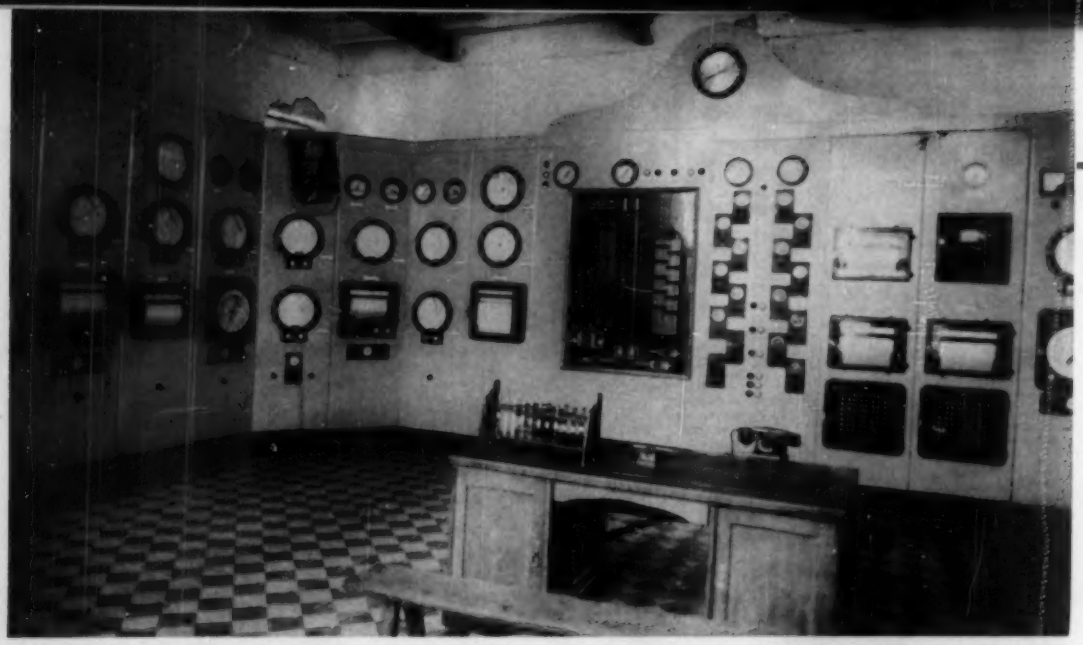
Even at 600° F., the average system pressure is only 30 psig with Aroclor. Low pressure means lower operating and supervisory costs, in addition to significant savings on equipment, installation and maintenance.

Get the facts about Aroclor and the distinct advantages of International-LaMont Aroclor Heaters. Write today for Bulletin 1300.

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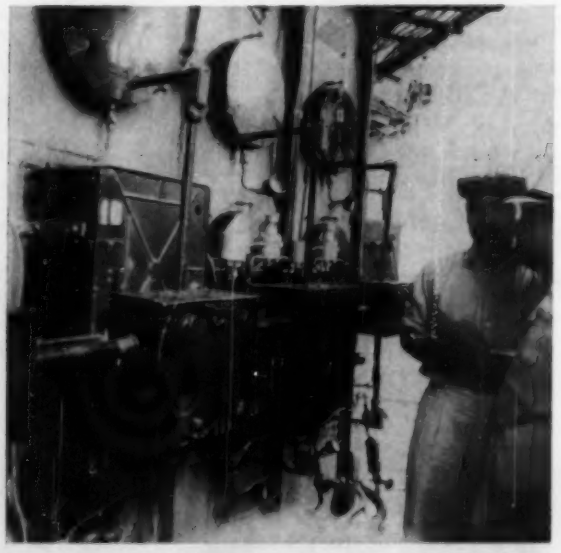
One of three catalytic cracking unit control rooms at modern 100,000 barrel-per-day refining plant in Baku.

The status of automatic control in the Soviet Union

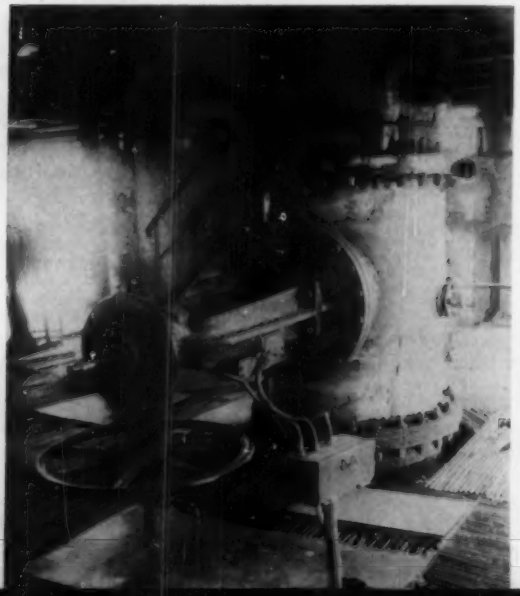
A photo record of visits to the Institute of Automatics and Telemechanics at Leningrad, and to a modern 100,000 barrel-per-day oil refinery at Baku. Exclusive **CEP** photos from David Boyd of Universal Oil Products.



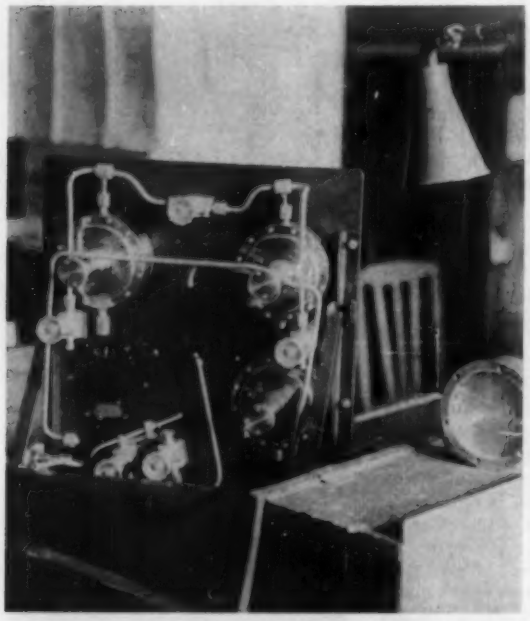
David Boyd, past chairman of A.I.Ch.E. Process Control Committee, discusses a Russian controller with T. Kalytvyanaskaya, superintendent in charge of the sulfuric alkylation unit in Baku.



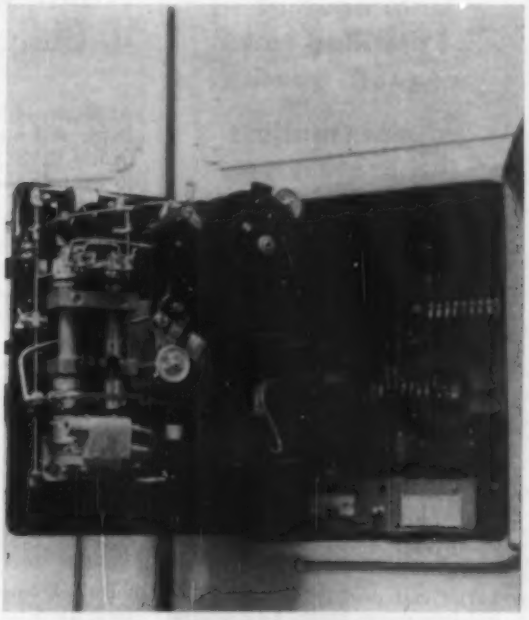
Rear view of control panel, showing a test installation of new type of "stacked" controllers.



Electric slide valve actuator on one of the fluid catalytic cracking units at the large Baku refining installation.



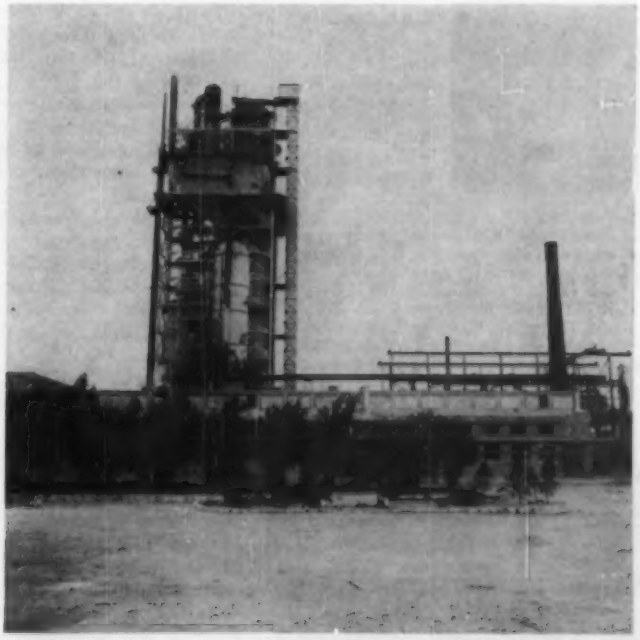
Dielectric constant measuring instrument presently under construction at the Petroleum Instrument Development Laboratories in Leningrad.



Interior view of infrared analyzer on display at the permanent exhibition of Industrial and Agricultural Achievement located near Moscow.



Interior view of continuous colorimeter developed at Petroleum Instrument Development Laboratories in Leningrad.



Overall view of a fluid catalytic cracking unit at the Baku refinery.

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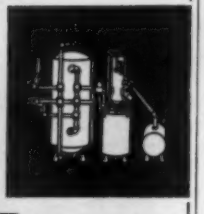
—from smallest laboratory to largest plant need

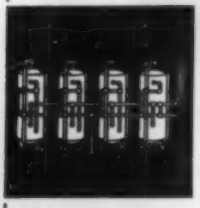
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people in management and technology

Whitman of MIT to State Dept. post

Head of MIT Chem. engineering Dept. will succeed Wallace R. Brode as Science Advisor to Secretary of State.

Walter G. Whitman, on leave of absence from MIT, has been appointed science advisor to the U.S. Secretary of State. Whitman has been head of the Dept. of Chemical Engineering at MIT since 1934.



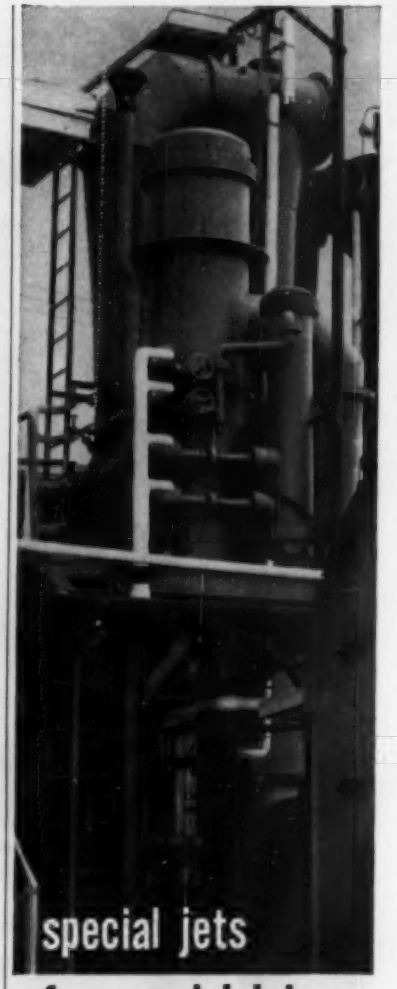
Whitman served on the General Advisory Committee to the Atomic Energy Commission from 1950 to 1956, was a member of the Office of Defense Management's Science Advisory Committee from 1951 to 1955, Chairman of the Research and Development Board of the Dept. of Defense from 1951 to 1953, and a member of the National Advisory Committee for Aeronautics from 1951 to 1953.

Early in 1955, Whitman was selected by Dag Hammarsjkold, Secretary-General of the UN, to plan and operate the first world scientific meeting on atomic energy, and to be Secretary-General of the UN International Conference on the Peaceful Uses of Atomic Energy, held in Geneva that year.

During World War II, Whitman, in 1941, was appointed as petroleum consultant for the Office of Production Management. From 1942-1945, he served full time as director of the Basic Chemicals Div. of the War Production Board.

President of A.I.Ch.E. in 1956, Whitman is a member of several other professional societies and a fellow of the American Philosophical Society.

In his new State Dept. post, Whitman, among other duties, will supervise the Science Attache program. Since 1957, ten U.S. embassies abroad have been staffed with top technical men to facilitate scientific exchanges with other countries, and to act as advisors to other members of the embassy staffs.



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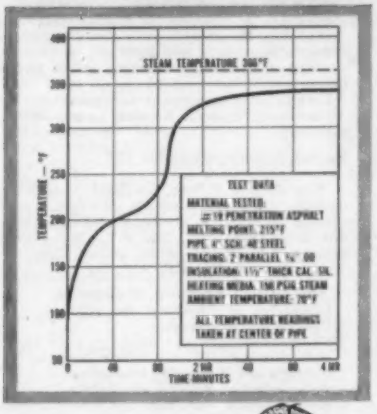
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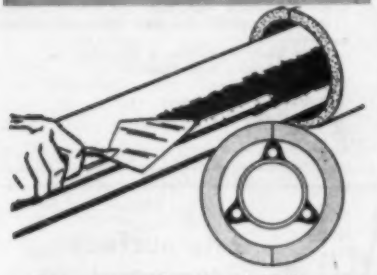
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future meetings

1960—MEETINGS—A.I.Ch.E.

• Longview, Wash., Oct. 7, 1960. **Pacific Northwest Section A.I.Ch.E. One-Day Regional Meeting** on general topics. Mtg. Chmn.: B. O. Bathiany, Weyerhauser Co., Longview.

• Washington, D. C. Dec. 4-7, 1960. Statler Hotel. **A.I.Ch.E. Annual Meeting.** Gen. Chmn.: J. L. Gillman, Jr., 1700 K St., N. W., Wash. 6, D. C. Tech. Prog. Chmn.: D. O. Myatt, Science Communication, Inc., 1079 Wisconsin Ave., N. W., Wash. 7, D. C.

Air Pollution—A. J. Teller, U. of Florida, Gainesville, Fla.

Unsteady-State Instrumentation—T. J. Williams, Monsanto Chem. Co., St. Louis, Mo.

Fluid Dynamics—A. C. Acrivos, U. of California, Berkeley, Calif.

Information & Communications—R. O'Dette, NSF, Wash. D.C.

Nuclear Reactor Operations—R. L. Cummings, Atomics International, Canoga Park, Calif.

Nuclear Chemical Plant Safety—C. E. Dryden, Ohio State U., Columbus, O.

Phase Transitions—G. Bankoff, Northwestern U., Evanston, Ill.

Sales Overseas—J. Costigan, The Sharples Corp., 501 Fifth Ave., New York 17, N. Y.

Chemical Engineering-A Vital Link in Broadening the Uses of Agriculture Crops—J. E. Simpson, U.S.D.A.

Chemical Warfare-Dispersal of Materials in Aerosol Form—L. E. Garono, Army Chemical Corps.

Role of the Chemical Engineer in Environmental Health Engineering—W. L. Faith, Air Pollution Foundation, 2556 Mission St., San Marino, Calif.

Feeding, Clothing, and Protecting the Combat Soldier—Leo Spano, Quartermaster R. & Eng. Command, Natick, Mass.

Phenomena Affecting Materials in Extreme Environments—J. Hearne, Air Force R. & Eng.

Impact of Govt. Programs on Chemical Engineering Education—W. K. Davis, Bechtel Corp., San Francisco, Calif.

Toxic Plant Construction—L. E. Garono, Army Chemical Corps.

Potentialities of Fuel Cells as Power Sources—P. Greer, Army OOR.

Saline Water Conversion—J. J. Strobel, OSW, Dept. Int.

Chemical Engineering in the Mineral Industry—H. Perry, Chf. Bit. Coal Res. Br., U.S. Bureau of Mines.

Rocket Propellants—W. E. Sheehan, DDRE.

Economic Evaluation of New Processes—J. H. Hirsch, Gulf R&D Co., P. O. Drawer 2038, Pittsburgh 30, Pa.

New Crystallization Techniques — H. M. Schoen, American Cyanamid Co., 1937 W. Main St., Stamford, Conn.

Heat Transfer—M. Altman, Gen. Elec. Co., 3198 Chestnut St., Philadelphia, Pa.

1961—MEETINGS—A.I.Ch.E.

• New Orleans, La., Feb. 26-March 1, 1961. Hotel Roosevelt. **A.I.Ch.E. National Meeting.** Gen. Chmn.: O. P. Wiedeman, Cyanamid, New Orleans, La. & H. E. O'Connell, Ethyl Corp., Baton Rouge, La. Tech. Prog. Chmn.: A. L. Regnier, Petroleum Chem., P. O. Box 6, New Orleans 6, La.

Brainstorming Technical Problems—G. C. Szego, Space Technology Labs., P. O. Box 95001, Los Angeles 45, Calif.

Kinetics of Catalytic Reactions—M. Boudart, Princeton U., Princeton, N.J.

Petrochemicals—Future of the Industry on the Gulf Coast—J. A. Sherred, Monsanto Chem. Co., St. Louis 66, Mo.

Filtration—F. M. Tiller, U. of Houston, Houston, Texas.

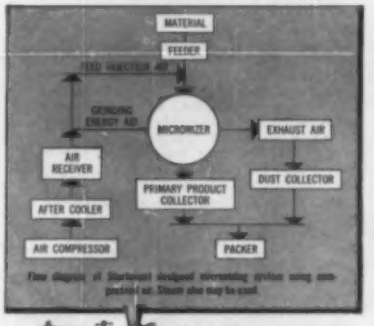
Settling—A. G. Keller, La. State U., Baton Rouge, La.

Future Processing Technology in the Petroleum Industry—A. F. Kaulakis, Process Res. Div., ESSO.

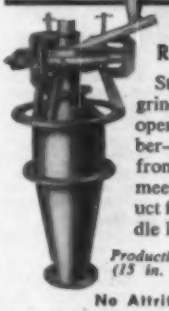
continued on page 148

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future meetings

from page 147

Education and Professionalism—R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, Ohio.

Mathematics in Chemical Engineering—R. L. McIntire, Mathematical Eng. Assoc., 3108 Sweetbriar, Fort Worth 9, Texas.

Evaluation of R&D Projects—L. A. Nicolai, 239 Parsonage Hill Rd., Short Hills, N.J.

Liquid-Liquid Extraction — R. B. Beckman, Carnegie Tech., Pittsburgh 13, Pa.

New Petrochemical Processes in the Area—B. G. Caldwell, Dow Chem. Co., Plaquemine, La.

Materials of Construction—R. V. Jelinek, Syracuse U., Syracuse, N.Y.

Thermodynamics—J. J. Martin, Ch.E. Dept., Univ. Calif., L. A. 24, Calif.

Use of Probability Mathematics in Economic Evaluation—A. G. Bates, Atlas Powder Co., New Murphy Rd., Wilmington 99, Del.

International Chemical Picture—L. Resen, CEP.

Selected papers—E. Mannings, Shell Oil Co., Norco, La.

• Cleveland, O., May 7-10, 1961, Hotel Sheraton, Cleveland. **Joint A.I.Ch.E. National Meeting with Ch.E.Div. C.I.C.** Gen. Chmn.: H. Pforsheimer, Jr., Standard Oil Co. (Ohio), Cleveland, O. Tech. Prog. Chmn.: R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, O.

Petrochemicals as Starting Materials for Polymers—L. F. Marek, A. D. Little, 30 Memorial Dr., Cambridge 42, Mass.

Fluid Mechanics—W. H. Gauvin, McGill Univ., Montreal, Que.

Laboratory and Pilot Plant Techniques—J. T. Cumming, School Eng., Penn College, Cleveland 15, O.

Process Dynamics (Theoretical)—R. M. Butler, Imperial Oil Co., Sarnia, Ont.

Synthesis Processes for Isoprene—T. A. Burtis, Houdry Process Corp., 1528 Walnut St., Phila. 2, Pa.

Radioactive Materials for Process Control—J. R. Bradford, College of Eng., Texas Tech. College, Lubbock, Tex.

Process Dynamics (Applied)—L. M. Naphtali, Ch.E. Dept., Brooklyn Polytech., Brooklyn, N.Y.

New Synthetic Rubber Types—P. M. Lindstedt, Goodyear Tire & Rubber Co., Ch.E. Div., Akron 16, O.

Coalescence—R. Kintner, Illinois Inst. Tech., Chicago 16, Ill.

Management Criteria for Capital Investment—C. F. Prutton, Food Machy. & Chem. Co., 161 E. 42d St., New York 17, N. Y.

Chemical Engineering in Metal Refining—W. M. Campbell, Chem. & Met. Div., Atomic Energy of Can., Chalk River, Ont.

Heavy Metal Mfr.—L. P. Scoville, Diamond Alkali, Union Commerce Bldg., Cleveland 14, O.

Applications of High Speed Photography—A. I. Johnson, Univ. of Toronto, Toronto 5, Ont.

Bulk Fibrous Materials—R. M. Christiansen, Stearns-Roger Mfg. Co., Denver, Colo.

Pulp and Paper—J. L. McCarthy, Univ. Washington, Seattle 5, Wash.

New Research Techniques — D. Hyman, Cyanamid, 1937 W. Main St., Stamford, Conn.

Mixing-Fundamentals—J. Y. Oldshue, Mixing Equipment Co., P. O. Box 1370, Rochester, N. Y.

Mixing-Applications — E. E. Ludwig, Dow Chemical, Freeport, Tex.

Cash Flow Methods in Economic Analysis—D. D. MacLaren, Esso Research & Eng., P. O. Box 215, Linden, N. J.

Selected Papers — D. J. Porter, Diamond Alkali, P. O. Box 348, Rsch. Center, Painsville, O.

Student Program—H. B. Kendall, Case Inst., 10900 Euclid Ave., Cleveland, O.

Deadline for papers: Dec. 7, 1960.

• Lake Placid, N. Y., Sept. 24-27, 1961, Lake Placid Club. **A.I.Ch.E. National Meeting.** Gen. Chmn.: B. I. MacDonald, Jr., G. E., Waterford, N. Y. Tech. Prog. Chmn.: E. R. Smoley, 30 School Lane, Scarsdale, N. Y.

Control of Corporate Investment Costs
Chemical Engineering in the Photographic industry
Techniques Used to Improve Profitability of petroleum processes
Recent Developments in Mechanisms of chemical reactions
Chemical and Physical Properties of Materials at High Temperature
Radiation Effects
Synthetic Natural Rubber
Chemical Engineering in Management
Materials Handling
Petrochemicals in the 1960's
World Wide Sales Challenges of the Sixties in the CPI
Economics of Equipment Selection
Economics Theories Applied to Growth Industries
Market Development in the CPI

• New York, N.Y. Dec. 3-6, 1961. Hotel Commodore. **A.I.Ch.E. Annual Meeting.** Gen. Chmn.: L.J. Coulthurst, Foster Wheeler Corp., 666 Fifth Ave., N.Y. 19, N.Y. Tech. Prog. Chmn.: A.V. Caselli, Shell Chem. Corp., 50 W. 50 St., N.Y. 20, N.Y.

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Nuclear Technology
Recent Advances in Ferrous Pyro-Metallurgy
Hydro-Metallurgy
Pilot Plants
Polymer Handling Equipment
Process Dynamics
Control and Simulation
Radiation and Furnace Design
Student Program

Unscheduled Symposia

Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.

Computers in Optimum Design of Process Equipment: Chen-Jung Huang, Dept. of Chem. Eng., Univ. of Houston, Cullen Blvd., Houston 4, Texas.

Solar Energy Research: J. A. Duffie, Director of Solar Energy Laboratory, Univ. of Wisconsin, Madison, Wis.

Hydrometallurgy—Chemistry of Solvent Extraction: G. H. Beyer, Dept. of Chem. Eng., Univ. of Mo., Columbia, Mo.

Process Dynamics as They Affect Automatic Control—D. M. Boyd, Universal Oil Prods., Des Plaines, Ill.

Drying—R. E. Peck, Ill. Inst. of Tech., 330 So. Federal, Chicago, Ill.

Put this on your calendar

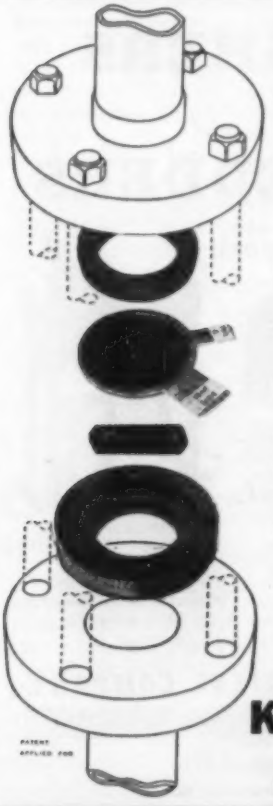
The Petrochemical and Refining Exposition to be held in conjunction with the National A.I.Ch.E. Meeting in New Orleans, Feb. 26-Mar. 1, 1961. The theme will be the Chemical Engineer's role in design and development of petroleum and petrochemical facilities.

One of the largest single unit sulphuric acid plants in Greece will be built by Chemical Construction Ltd., English subsidiary of the New York firm. The 376 metric tons per day units at Ptolemais, Northern Greece, will be erected for the Greek Ministries of Industry and Coordination as part of a nitrogenous fertilizer factory.

An expansion in phthalic anhydride production capacity will take place at Allied Chemical's Philadelphia, Pa., plant. Time schedule for the expansion, termed substantial by the company's Plastics and Coal Chemicals Division, is completion by early 1961.

A new biochemical laboratory in Arecibo, Puerto Rico, will extract products from rum distillery slops (mosto). Parent firm of the Calbiochem Caribe, as it is called, is California Corp. for Biochemical Research. Another activity of the new firm will be a search for biochemical by-products from other agricultural products of Puerto Rico.

The new carbon disulfide plant now nearing completion at Stauffer Chemical's Delaware City, Delaware, site will use a permanent manpower force provided by Catalytic Construction to maintain the facilities.



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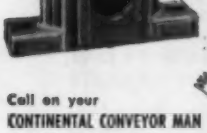


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industrial news

Chem engineers in computer use poll

Some six percent of the digital computers in U.S. are used by chemical engineers, A.I.Ch.E. survey shows. Industry computer groups assist in chemical engineering studies.

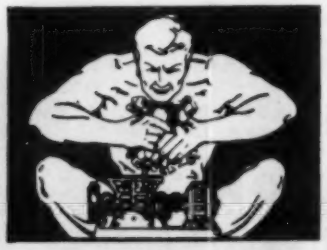
ABOUT SIX PERCENT of the installed digital computers in the United States are actively serving chemical engineers, a recent survey shows. In the poll of computer installations undertaken annually by the A.I.Ch.E. Machine Computation Committee through the local sections, those companies, universities, and government units employing a significant number of chemical engineers were questioned. In this way a representative sampling of chemical engineers using computers was obtained.

The report shows that of the different makes of digital computers in use by chemical engineers, 59 are IBM 650's. This is four percent of the total number of 650's in use in the United States. Thirteen Burroughs 204, 205 machines are in use by Chemical Engineers, and this is 12% of the total number of 204, 205's. Figures on estimated number of machines in-

Table 1. Digital computers used by chemical engineers.

	Number reported in A.I.Ch.E. census	Estimated number installed in U.S.*	Percent
IBM 705	6	175	3
704	6	130	5
709	3	50	6
650	59	1625	4
305	7	775	1
UNIVAC			
Scientific	3	45	7
I, II	7	73	10
SS80, 90	3	70	4
Burroughs			
220	3	40	7
204, 205	13	109	12
Royal McBee			
LGP-30	31	425	7
Bendix			
G-15	26	342	8

**Estimates published by John Diebold & Associates—July 25, 1960.*



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stalled in the U.S. are from John Diebold & Associates. They published the results of a national survey of digital computer installations in their *Automatic Data Processing Newsletter*, July 25, 1960 (see Table 1).

While no figures for analog computers are readily available, the use of analogs in the chemical processing industries is indicated in Table 2.

Table 2. Analog computers used by chemical engineers.

Electronics Associates	PACE	9
Reeves	REAC	3
Beckman	EASE	1
Others (incl. Heathkit units)		7

A question on the size of computer organizations, and mathematical and statistical groups available to assist chemical engineering studies, brought some interesting answers. Approximately 561 technical people are employed in the operations of computers by 73 of the organizations responding to the census. In addition, 37 organizations indicated that they had a total of 294 technical people employed in their mathematical and statistical groups. The number of hours in the training courses ranged from a high of 160 to a low of three.

A 75% caprolactam monomer capacity increase is underway at Allied Chemical's National Aniline Division, Hopewell, Va. Also in progress is an expansion in caprolactam polymer, nylon tire yarn, and other fabric and industrial units at the Chesterfield, Va. facilities of the company. When finished in mid-1961, the expansion will nearly triple present company capacity for both caprolactam polymer, and caprolan nylon.

A second polyethylene plant for Mitsubishi Petrochemical will be designed and engineered by Stone and Webster. The plant, to be located at Yokkaichi, near the seaport of Nagoya, will have simplified cracking furnaces and acetylene removal facilities. The furnaces will operate on both gas and oil. Materials and equipment are to be supplied by Japanese industry. Completion schedule is some time next year.

Production of wet process phosphoric acid will be doubled at American Cyanamid. An addition to the company's Brewster, Fla., plant will bring capacity to about 400,000 tons annually of wet process 54% phosphoric acid. The new facilities will also provide an increased tonnage of triple superphosphate.

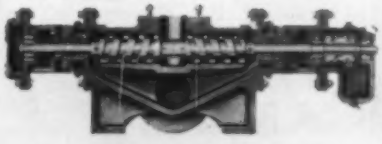
46 *Sier-Bath* ROTARY PUMPS

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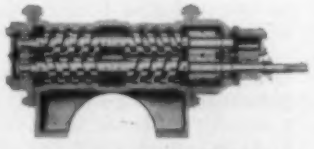
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people in management and technology

Professional Progress Award to Pfann

William G. Pfann, Bell Telephone Laboratories, will receive the 1960 A.I.Ch.E. Professional Progress Award. He was selected for his work in the field of zone melting by the Awards Committee and Council.

Pfann's basic paper on zone melting was published in 1952. In this he put forth his concept of melting a small part of a material to be crystallized instead of all of it. While the principle of purification by crystallization has been used for hundreds of years with no essential change, this discovery led to completely new ways of using the crystallization principle as well as to increased effectiveness of crystallization as a purification technique. Pfann conceived, in addition, a radically new solution to the problem of extreme purification of germanium. Recently, in developing the zone leveling technique for growing highly perfect single crystals of germanium, he was mainly responsible for a fundamental breakthrough in the understanding of dislocations. He is at present studying means of improving the efficiency of techniques, and adapting these techniques to large scale operations.

Pfann has two basic patents issued in his name, and several more issued or pending on other phases of zone melting. He has published a book, *Zone Melting* (John Wiley, 1958). He is a member of AIME, American Society for Metals, American Physical Society, and Tau Beta Pi. In 1955, the Mathewson Gold Medal was awarded to him by AIME. ASM honored him with the Albert Sauveur Achievement Award in 1958, and he received the Clamer Medal from the Franklin Institute three years ago.

Presentation of the Professional Progress Award will be made to Pfann in Washington, at the National Meeting Dec. 4-7.

Norman C. Updegraff has been elected president, Louisville Fire Brick Works. Updegraff, executive vice president of the Louisville, Ky. firm since the first of the year, took over his new post September 1. He was formerly with Girdler Construction.

Henry Eyring has been selected lecturer for the Fifth E. P. Schoch Series. His subject will be Rate Processes. Eyring, dean of the graduate school and Professor of Chemistry and Metallurgy at the University of Utah, will give an evaluation of future trends in the field, as well as a discussion of the modern theory of rate processes. The Schoch Lectures are held at the University of Texas each October.

Carl W. Lintner has been promoted to superintendent of overseas engineering, Parke, Davis & Co. Lintner, who joined the company in 1939, moves up from the post of overseas engineering manager.

Robert E. Hochscheid has been transferred to Dorr-Oliver's new office in Santiago, Chile. He will hold the post of technical representative. Hochscheid was formerly in Johannesburg, South Africa.

Frank E. Brewster has been named manager of intermediates at GE's Silicone Products Department, Waterford, N. Y. He moves up from his position as manager of the pilot plant semi-works.

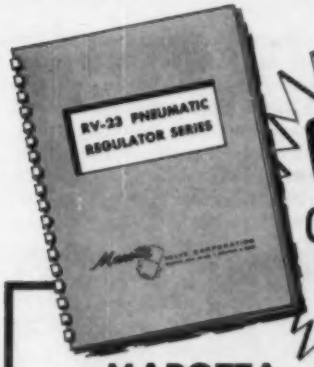
Thomas E. Ban has been elected vice president-research, McDowell Co. Ban, who joined the company in 1955 as director of research, will handle the operation of the Dwight-Lloyd Research Laboratories of applied minerals processes research.



Melvin S. Cagen has been appointed plant technical superintendent, Kordite Co., Macedon, N. Y. Previously with Olin-Mathieson and Heyden Chemical, Cagen holds a chemical engineering degree from the University of Maryland. He also did graduate work at Columbia and Princeton.

John E. Stauffer was awarded a doctorate degree by Worcester Polytechnic Institute, the first Ph.D. in chemical engineering awarded in the history of the college. He begins his industrial career in the Richmond, California, Research Center of Stauffer Chemical.

continued on page 154



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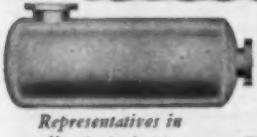
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people

from page 152

Evan F. R. Quarton has been appointed assistant chemist on the laboratory staff of The Lea Manufacturing Co. A graduate of the University of Massachusetts, Quarton was formerly with the Factory Insurance Association as chemical plant inspector.

Loren Miller has joined California Research La Habra Laboratory as research engineer. He comes to the company from Fluor Corp.

William C. Mallison is a new member of the staff of Badger Manufacturing. He takes over the post of process engineer.

Clifford C. Furnas has been elected to the board of directors, Hooker Chemical. Chancellor of the University of Buffalo since 1954, Furnas also served as Assistant Secretary of Defense for Research and Development in Washington, D. C. for two years of this period, during which time he was on leave from the University.

Charles F. Bonilla, Professor of Chemical Engineering, Columbia U., has gone to Chile, where he will represent engineering in a mission sent by the National Academy of Sciences. The one-month project is to assist the seven Chilean universities to develop their programs and faculties. This takes on particular significance since university facilities and equipment have suffered severe damage in the recent earthquakes.



Guy T. McBride, Jr. has been elected vice president, Texas Gulf Sulfur Co. He joined Texas Gulf in 1958, after acting as consultant to the company for several years. Later, he became manager, Research Department. McBride was formerly associate professor of chemical engineering and Dean of Students at Rice Institute.

L. A. Bullington and **B. S. Greenwood** have been promoted to senior supervising engineers at Humble Oil & Refining's Technical Division, Baytown, Texas. Bullington heads the economic analysis section, and Greenwood the butyl and butadiene section.

William P. Hagenbach has been ap-

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pointed director, engineering research, A. E. Staley. He was, until joining the Decatur, Ill. firm, with Du Pont.

In the manufacturing division of A. E. Staley, **G. James Dustin** was promoted to plant superintendent.

Harry E. Roche retired as manager, Port Arthur, Texas, plant of Koppers Plastics Division. A veteran of 26 years service, Roche, was, until 1959, a director of the Texas Chemical Council.



Arthur B. Cummins has retired as manager, Central Chemical and Physical Research Department, Johns-Manville Research Center, after 36 years with the company. Cummins holds 17 patents on silicates, diatomite, magnesia, and scientific apparatus. He is also widely published in the fields of asbestos mining, mineralogy, and filtration technology of silica and diatomaceous earth.

John E. Cooper is now with Crawford and Russel, in Stamford, Conn. as a process engineer. He was previously with Allied Chemical's National Aniline Division.

Edwin H. Young has been elected vice president, Michigan Society of Professional Engineers. He will serve a one year term. He is a professor in the Chemical and Metallurgical Engineering Department, University of Michigan. Director of the Wolverine Tube Finned Tube Heat Transfer Project at the University's Research Institute, Young is at present working on a book on the subject, along with **Professor D. L. Katz.** Titled *Heat Transfer Through Finned Tubes,* it will be published by John Wiley.



A. J. Teller has been appointed technical director, Colonial Iron Works. He originally served the company as process design consultant, and, since 1958, as consulting technical director. Before that, Teller was professor and graduate research professor of chemical engineering at the University of Florida. He is chairman of the Pollution Control Division, National Program Committee, A.I.Ch.E., and a former chairman of the Peninsular Florida Section.

Paul E. Geiser has been promoted to

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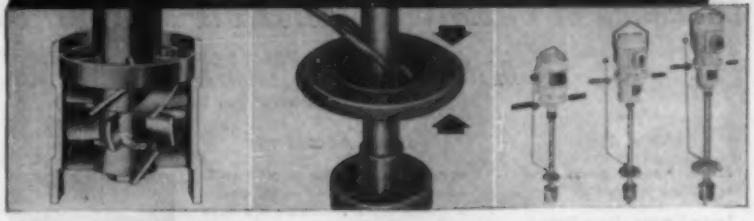
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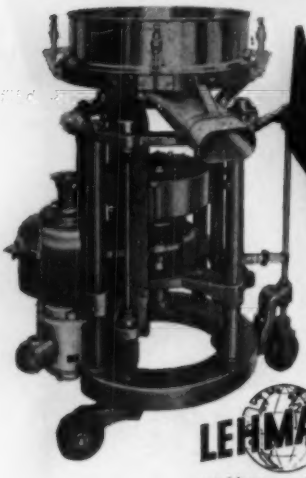
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people

from page 155

the new position of general manager, petrochemical manufacturing, Continental Oil. Formerly manager of the detergents division, he will continue to headquarter in Houston.

William F. McDonald moved up to the post of manager, customer services, and **Gerald M. Platz** to manager, plant services, at U. S. Industrial Chemicals.



William A. Bain has been elected vice president, Air Products. A recent addition to the firm, Bain was formerly executive vice president, Vitro Laboratories. His new responsibilities, as general manager, Defense and Space Division, are heading up the company's missile and rocket programs.

H. Resnick has been appointed supervising research engineer, process and plant design section, Richmond Laboratory, California Research.

John Zotos has been appointed assistant professor, Northeastern U. Department of Mechanical Engineering. He was formerly assistant chief, Watertown Arsenal, Rodman Laboratory Experimental Foundry Branch.



Emil Ott has resigned from his post as vice president, research and development, Food Machinery and Chemicals chemical division. He will continue as part time consultant for the company, and also devote himself to academic activities. Ott was a member of the board of directors, ACS, from 1948-50. He was recently president, American Institute of Chemists, and Chairman of the Board. A past president, American Section, Societé de Chimie Industrielle, Ott has also been active in the Gordon Research Conferences.

L. J. Garrison moves into the post of supervisor, field services section, Jefferson Chemical. He will be located at the R&D Lab, Austin, Texas. With the company since 1952, Garrison has held various posts in customer technical service, principally in the field of surface-active agents.

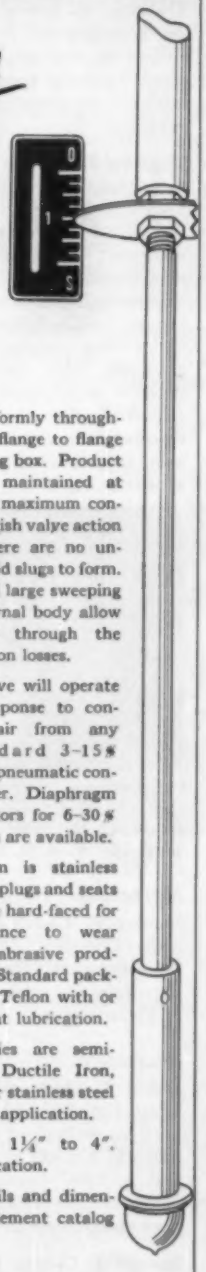
Among the officers and board mem-

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people

continued

bers of the Natural Gasoline Supply Men's Association recently installed for the 1960-61 year was **F. W. Bell**, second vice president. **Charles E. Webber**, NGAA president, is an ex-officio member.

Arthur L. Kohl has joined Atomics International (North American Aviation), as assistant group leader, Organic Reactors Department. Formerly chief chemical engineer, Fluor Research Division, Kohl was also associated with Turco Products as research engineer. He is author of the book, *Gas Purification*, and a contributor to the *McGraw-Hill Encyclopedia of Science and Technology*.

Thonet C. Dauphine has been promoted to senior development engineer, Hooker Chemical, General Development Department. He will concentrate on special projects of a long-range nature.

Robert W. Cairns has been named chairman-designate, National Academy of Sciences National Research Council's Division of Chemistry and Chemical Technology. Cairns is director of research, Hercules Powder. Outgoing chairman is **Ernest H. Volwiler**, president of Abbott Laboratories. **Robert C. Elderfield**, professor of chemistry, U. of Michigan, will serve this year.

Clarence R. Flynn takes over the new assignment of general foreman-technical, at the Henry, Ill., general chemicals plant, B. F. Goodrich. Formerly head of the plant's technical department, he will head the production department.

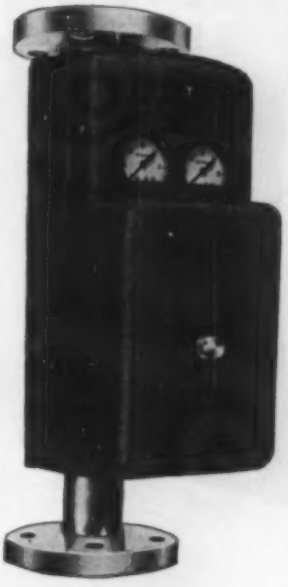
L. E. Gressingh moves into the position of staff engineer, General Tire & Rubber Chemical Division. Formerly technical superintendent, Mogadore plant, Gressingh holds a chemical engineering degree from the Polytechnical University of Budapest.

Edward G. Bobalek, professor of chemical engineering at Case Institute, was director of a September symposium on the physical processes of the drying and aging of paint. Titled "Paint from Wet to Dry", the symposium was sponsored jointly by the Cleveland Society for Paint Technology, Cleveland Paint, Varnish and Lacquer Association, and Case Institute.

Bert S. Taylor was named to the U.S. Department of Commerce post of assistant director, mobilization planning,

continued on page 158

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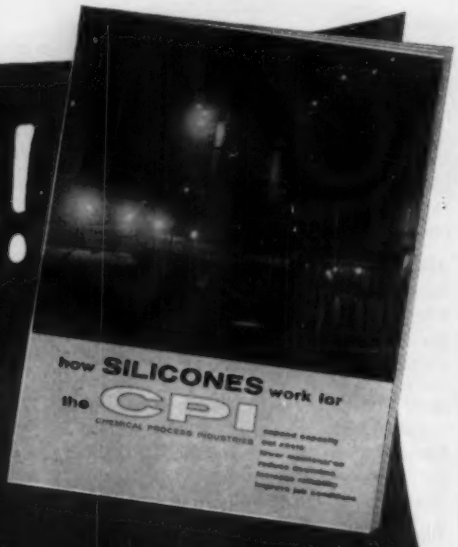
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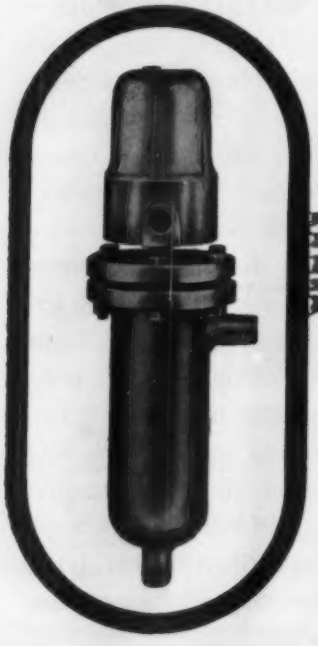


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people

from page 157

Chemical and Rubber Division, Business and Defense Services Administration. Taylor is director of marketing and purchasing, Food Machinery and Chemicals, Chemicals and Plastics Division. He comes to the post under an arrangement by which industry makes the services of key executives available for a temporary assignment without compensation from the government.

Herman R. Thies, general manager, Goodyear Tire & Rubber's Chemical Division, has been honored on completion of 30 years service with the company. Presentation of a service award was made during a testimonial dinner in Thies' honor at the end of the division's 1960 sales conference. Thies has headed the company's chemical sales operations since the division was organized in 1948. He joined Goodyear in 1930 as a rubber research compounder, and entered the sales field in 1942 in connection with synthetic rubber.



C. O. McNeer (r) sales manager Goodyear Chemical Division, making presentation of oil portrait from division personnel to H. R. Thies.

Marketing

Stanley W. Cairns has joined General Mills Chemical Division as a sales representative. Headquarters are at the division's sales and service office in Philadelphia.

Necrology

David T. Shaw, 66, manager of Atlantic Refining's Philadelphia refinery until his retirement in 1958. He joined Atlantic in 1929 as a senior engineer, and in 1937 became superintendent of the refinery. Shaw took over the post of manager in 1952.

Samuel J. Cohen, 65. He was president, Anderson Refining Co. and Enterprise Chemical, and a director of Dover Chemical. He was also a co-sponsor, along with Georgia Institute of Technology, of a research

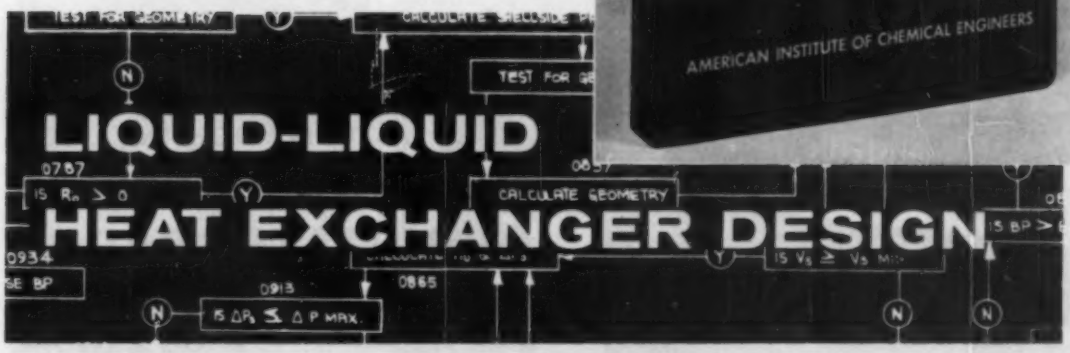
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local sections

New Chem Engineering building dedication at Ohio State

DEDICATION OF THE NEW chemical engineering building at Ohio State University climaxed the year's activities for the **Central Ohio Section** (*J. D. Jackson*). Among those taking part in the May dedication ceremonies were Joseph H. Koffolt, chairman, Department of Chemical Engineering at the University, Jerry McAfee, vice president of Gulf Oil and president of A.I.Ch.E., and N. G. Fawcett, president of Ohio State University.

Industry contribution

The $2.4 million building, the first in the University's planned Engineering Center, marks a new industry plan, a major development. It is expected to be an important example to other industries in furthering their contributions to chemical engineering education. Of the funds raised for the building, a sum of $55,000 was contributed by industry, partly in cash and partly in equipment. The method is this: a company refurbishes second hand equipment, paying for instrumentation, cleaning, painting, shipping, and storage, and gives the equipment to a Chemical Engineering Department. The department has an assessor come in, and the company deducts the equipment as a gift at the amount specified by the assessor. It is a low cost way for industrial firms to help improve chemical engineering departments by using up equipment in their store rooms. It is of course an invaluable boon to the schools involved.

At Ohio State, equipment in the old building was dismantled and reassembled in the new structure by the June graduating class at an estimated saving to the University of over $50,000. In addition to 50 laboratories, thirteen of which are individual labs for up to 35 graduate students, the facilities include a 52 foot high operations laboratory. Seventy graduate students can be accommodated in other special laboratories, such as mass transfer, kinetic thermodynamics, etc.

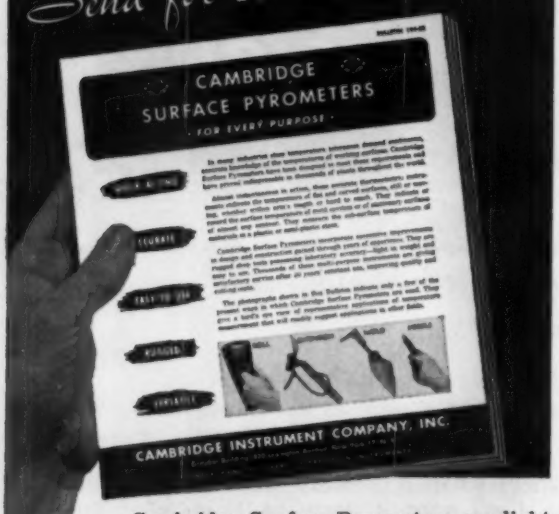
Banquet

The Section ended its all-day get together with the annual banquet. Among the guests were Harry Warner,



Shown at speakers' table at Central Ohio Section annual banquet: Sid Kirkpatrick, Jerry McAfee and Joe Koffolt.

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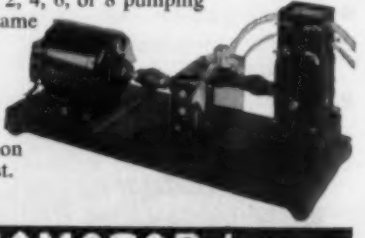
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president, B. F. Goodrich Chemical; F. J. Van Antwerpen; Jerry McAfee, and Joe Koffolt. Featured speaker was Sid Kirkpatrick, retired vice president of McGraw-Hill, who titled his speech "Chemical Engineering, Onward and Upward."

Southwest Louisiana joint conference

The Annual Technical Conference of the **Southwest Louisiana Section** (*R. L. Goodkind*) was held at McNeese State College, Lake Charles, and jointly sponsored by the ACS local section. Nearly 100 attended the 16-paper meeting in May. Covered were such subjects as: *The First Seven Years in Ziegler Chemistry, Rosin for Paper Size, Product Improvement through Electrostatic Settling, Water Well Corrosion and Protective Measures* (an actual account of corrosion in local wells, plus a discussion of the material and methods used to combat this condition). Also taken up were: *Monitor Instruments* (a general discussion of process stream analyzers, and chromatography in gasoline dye identification).

Also meeting

A forum on chemical engineering curricula was held at the **Alton-Wood River Section** (*J. G. Huddle*) meeting in May. Brage Golding, head of the Department of Chemical Engineering, Purdue U., outlined past and present trends in curricula. Selected members of the local section presented short comments on what industry wants for the B.S. degree . . . Highlights of IGY accomplishments were presented to the **Southern California Section** (*E. F. Edwards*) in May. L. H. Adams, visiting professor of Geophysics, UCLA, discussed some significant IGY findings regarding the earth's core, stony mantle, crust, oceans, atmosphere, and radiation and magnetic fields. Remarkable advances have been made in our knowledge of the earth's crust and its radiation fields, he said . . . A panel discussion, *Marketing of New Products*, was featured at the **Fairfield County Section** (*J. Witheford*) in May. Local industries were represented by B. Cormack, American Machine and Foundry, J. House, Taylor-Reed, and A. M. Swift, American Cyanamid, on the panel . . . A tour of the State Power Authority Project, Lewiston, was taken by **Western New York Section** (*Reed Garver*) in June . . . **Western Massachusetts Section** (*J. F. Blumenfeld*) held its Annual Ladies' Night Dinner-dance in June. Speaker was Harold Simon, General Aniline and Film, who demonstrated textile dyes and colors

continued on page 162

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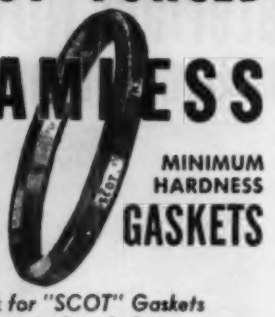
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local sections

from page 161

. . . Arthur May, professor of history at the U. of Rochester, addressed the **Rochester Section** (*Robert L. Cramer*) in May. Subject: *Behind the Iron Curtain* . . . Systems engineering was the **South Texas Section** (*G. H. Cummings*) topic in June. Edward P. Bartkus, director, systems engineering, in Du Pont's Engineering Service Division, was the speaker. He dealt mainly with the systems engineering approach to profits in the chemical industry . . . In June, **Detroit Section** members took a trip around the International Salt Mine located underneath the city . . . **The Southwest Washington Section** (*J. C. Tooley*) took a trip through Becco Chemical where they viewed Becco's electrolysis method of producing hydrogen peroxide.

A sulfuric acid plant started up in Manitoba, Canada, by Border Chemical, is producing above its 50 ton per day rated capacity. Presently operating with Canadian sulfur, the plant will be converted to process sulfur dioxide gas from the roasting of New Manitoba Mining and Smelting Co.'s sulfide concentrates.

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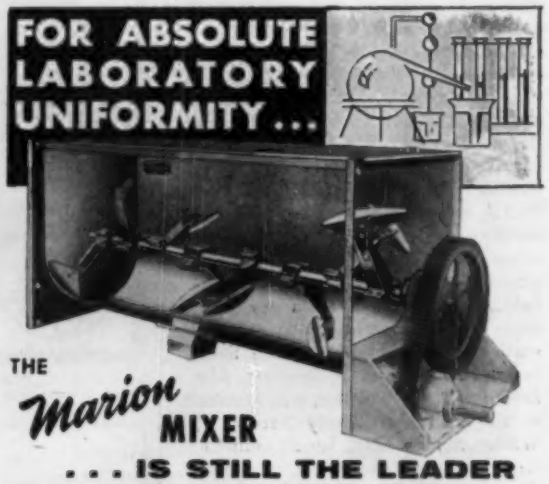
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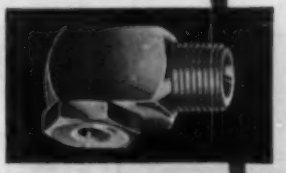
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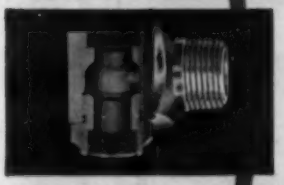
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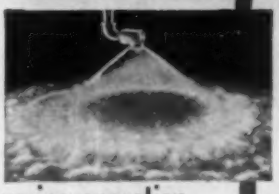
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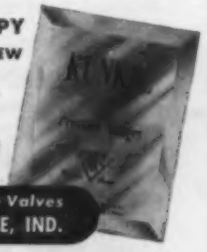
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(continued on page 168)

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(continued from page 165)

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Lancaster STAINLESS Lined Rot. Reactor; Jktd. 50" x 17'4"
2 Stainless Lined 11,000 Gal. Pressure Tanks; 10' x 18'7"
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2 Lehmann Amalgamators; S/S Lined; 32" x 44" x 36"; S/S Arms
Patterson-Kelley STAINLESS Twin Shell Blenders; 30-150 Cu. ft.
Oliver Dorrco NICKEL Rot. Vac. Filter; 6' x 3'; NICKEL access.
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2—Davenport 8' x 60' welded rot. dryers.
1—Buflovak 700 sq. ft. single effect forced circ. evap., T304 SS.
1—Buflovak 8' x 30' T316 SS rotary vacuum dryer, ASME.
1—Struthers-Wells 3500 gal. T316 SS jktd. reactor, 40/30 HP agit.
1—17,650 gal. T316 SS horiz. tank.
30—Sharples #AS-16V Inconel Centrifugals
1—Allis-Chal. 7' x 50' rotary dryer, ¾".
1—Buflovak 42" x 120" double drum dryer, ASME 125# drums—atm.
1—Niagara #510-28, T316 SS filter.
1—Oliver 5' 3" x 6' precoat rotary vacuum filter, UNUSED.
1—Buflovak 5' x 12' single drum vacuum dryer—UNUSED.
1—Struthers-Wells 630 sq. ft. T316 SS single-effect evap.
1—1960 sq. ft. T316 SS exchanger.

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These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Chemical, Civil, Electrical, Mechanical, Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members and non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60% of the first month's salary if a non-member, or 50% if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

Positions Available
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CENTRIFUGE ENGINEERS, graduate chemical or mechanical, with 10 to 12 years' experience with process equipment for responsible positions in: (a) Technical coordination; 3 to 5 years' technical experience with centrifuges required. Knowledge of German; reasonable freedom to travel. Will work closely with testing, production, sales and customers on engineering and related matters. (b) Sales coordination; 3 to 5 years' experience in selling centrifuges to industry; administrative ability; reasonable freedom to travel required. Will work with salesmen on major customer calls, provide training in selling and product applications, do related administrative assignments. Company may negotiate placement fees. Headquarters, upstate New York. W-9447.

CHEMICAL SUPERVISOR, degree in chemical engineering or chemistry, with business administration courses, to cooperate with laboratory and pilot plant in the design and engineering of new chemical processes. Will assist in supervision of general plant maintenance. Should have 5 to 10 years' related experience. Location, New Jersey. W-9445.

CHEMICAL ENGINEERS for technical (production) control; recent graduates preferred, for manufacturing/production, technical control work in all phases of pulp, paper and paper product manufacturing. Also similar activities in new products such as polyurathane foam, polystyrene containers and others. Salaries, from $6600 a year depending upon experience. Locations: Maine, Michigan and Penna. W-9436.

PATENT ATTORNEY, LL.B, with B.S. in chemical engineering or chemistry, with 3 to 5 years' experience in patent solicitation, to work as chemical patent attorney. Patent examining experience in U. S. Patent Office desirable. Will not consider a trainee. Salary, $10-$15,000 a year. Company will pay placement fee and relocation expenses. Location, Conn. W-9434.

CHEMICAL ENGINEER, Sales, to cover northern N. J., eastern N. J. and southern Connecticut, for the sale of mixing and grinding equipment for chemical and food processors. Salary, $10-$12,000 a year plus commission, car and expenses. Headquarters, Newark, N. J. W-9423.

CHEMICAL ENGINEER, degree in chemical engineering preferred, to work in laboratory of large manufacturer of plated die cast and metal stamped automobile accessory parts. Will assist in developing new techniques and processes in the electro-plating of metal parts and in the practical application of these techniques. Location, upstate N. Y. W-9417.

PAPER TECHNICAL SERVICE ENGINEER, graduate chemical, for lab and customer service assignment. Five to 10 years' experience in paper or paper chemistry. Salary, $8400-$9600 a year plus or minus. Location, northern N. J. W-9390(a).

EQUIPMENT CHEMICAL ENGINEER, B.Ch.E., B.M.E. or equivalent, with at least 3 years' experience in position related to process equipment design, evaluation, or selection, with either vendor or user. Duties will include application engineering and development, sales coordination and planning, some technical sales calls. Salary commensurate with experience. Location, Rhode Island. W-9386.

CHEMICAL ENGINEER with process equipment plant experience for safety engineering work (valves, pumps—petrochemical processing). Salary, $11-$12,000 a year. Location, Texas. W-9384.

CHEMICAL ENGINEERS OR CHEMISTS. (a) Research Engineer, Ph.D. in chemical engineering or chemistry preferred; B.S. in chemical engineering with 5 years' work in fields of combustion engineering, chemical processing, etc. Some background in fuel technology, combustion (not nuclear) required. Duties will include studies in theory and practice of carbon activation, design and supervision of laboratory and pilot scale units and checking out theories through production plant studies. Location, Penna. (b) Research Chemists, B.S. in chemistry or chemical engineering, with none to 3 years' experience. Duties will include study of methods of preparation and application of active carbon in chemical, pharmaceutical and municipal water fields. Advancement will be toward a position in industrial chemical sales division or a more responsible position within research division. Locations: 2 openings in Penna.; 1 opening in Ill. after training. W-9374.

CHEMICAL ENGINEERS AND CHEMISTS for research. Desire research proven organic or physical organic men to work in areas of papermaking resin synthesis, wax and polymer coatings, new products research, pulping, new processes for raw materials source, waste product research and high polymer research. Salaries open. Location, Penna. W-9370.

ENGINEERS (a) Market Analyst, degree in chemistry or chemical engineering, with additional work in economics and marketing helpful, with 1 to 5 years' experience in market research, sales or development of industrial chemicals desirable. Primary function will be collection and evaluation of market data on current and proposed company products. Will involve literature surveys, field calls on chemical consumers, statistical analysis and charting, etc. Salary $6000-$9000 a year. (b) Sales Trainee, Industrial Chemicals Division, degree in chemistry or chemical engineering, recent graduate considered. After training program (1 to 2 years) will be assigned to sales territory in some part of the country. Salary, $5700 a year plus. Location, western Penna. W-9365.

PRODUCTION SUPERVISOR, graduate chemical or mechanical engineer, with a minimum of 5 years' experience in process engineering or equivalent, with some first or second level production supervisory experience. Will be responsible for small plant production operation; will supervise shift foremen and operating crew of 25-35 men. Salary $8400-$12,000 a year. Location, South. W-9364(b).

CHEMICAL ENGINEERS (a) Production Engineer, graduate, for activated carbon division, with a minimum of three years in a chemical process industry; process studies leading to methods improvement; major engineering functions such as plant layout, design, equipment specifications, material balances, etc.; some experience in handling of solid materials by means of conveyors, elevators, screws, airslides, etc., high temperature processing equipment, etc. Will investigate and solve engineering problems; analyze equipment failures; assist maintenance in solution of problems, etc. Salary, $7200 a year. (b) Manufacturing Engineer, Industrial Chemical Division, graduate, with 3 to 10 years' experience in production or process improvement in chemical plant or oil refinery. Pilot plant experience acceptable. Duties will include continuing study of existing chemical production processes for purpose of recommending improvements to increase profits through reduction of manufacturing cost, etc. Salary, $7800-$11,400 a year. (c) Assistant Supervisor, Industrial Chemicals Division, graduate, with 5 or more years' experience in production of organic chemicals. Oxidation experience preferred but will train. Will supervise shift foremen, direct operating activities of plant, plan shutdowns, review plant conditions and correct operating conditions to attain best yield and production. Salary, $9600-$10,800 a year. Location, western Penna. W-9363.

San Francisco Office

CHEMICAL ENGINEER, graduate, with experience in field of explosive propellants and in possibly electromechanical devices using these. Involves analysis, development testing, evaluation. Test instrumentation experience helpful. Must be U. S. citizen. Salary open, plus stock. Location, San Francisco Peninsula. SJ-5484.

RESEARCH ENGINEERS, B.S., M.S. or Ph.D. in Ch.E., none to 5 years' experience in unit and/or pilot plant operations. U. S. citizens. Salary open. Locations, Los Angeles or Las Vegas areas. SJ-5481.

TECHNICAL ASSISTANT, chemical engineer or physicist, 25-32, with recent experience in development and production of plastic films and polyethelene. Also able to participate in manufacturing quality control work in plastics. Must be a fact finder and interpreter type. Able to make written and oral reports. Salary, $6300 a year upwards depending upon experience. Location, San Francisco East Bay. SJ-5475.

INSTRUMENT ENGINEER, B.S. in chemical, electrical or mechanical engineering, with 3 to 7 years' experience in refinery or chemical plant instrumentation, to engineer systems, write specifications for basic instruments, control systems, safety interlocks and relief systems for refineries and chemical plants. Some experience in atomic energy field helpful. Salary, $6860-$9440 a year. Must be U. S. citizens. Apply by letter. Location, Southern California. SJ-5445-R.

SALES ENGINEER, chemical, electrical or mechanical graduates, 29-35, with a minimum of five years' sales or process plant experience; to provide technical assistance to clients and promote sale of instrumentation (electrical, pneumatic, mechanical): to provide for control, actuators, direct reading or recording instrumentation for temperature, pressure, rate of flow, etc. in process plants (chemical, petroleum, petro-chemical, foods, etc.). For manufacturer's district office. Salary, $7200 a year and up plus company car and fringe benefits. Territory, Northwest area. Headquarters, Los Angeles, California. SJ-5430-R.

CHEMICAL ENGINEER, B.S. or M.S. in Ch.E., with experience in coal research necessary. Work under chief chemical engineer in research with major emphasis on coal research. Evaluate coal deposits under investigation and explore by-product possibilities. Participate in other research and evaluate in cooperation with industries and steam and nuclear development. Salary, $9000-$10,000 a year depending upon experience. For utility. Location, Pacific Northwest. SJ-5418.

RESEARCH, Physicist, Chemist, B.S. preferred, under 30. Research and development oriented, creative, mechanically inclined. Will be responsible for research and development from initial concepts to commercial application of new product; plan and organize work, evaluate results, recommend action, provide assistance in start-up. Direct technicians on containers, cartons, paper board and packaging. For a manufacturer. Salary commensurate with qualifications. Location, San Francisco North Bay. SJ-5425-R.

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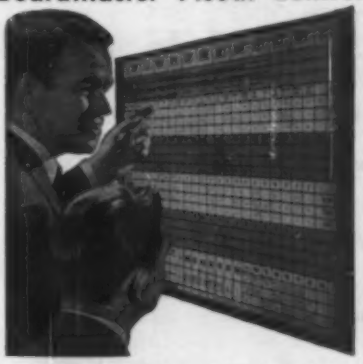
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News and Notes of A.I.Ch.E.

Recent council actions

Last month I presented some of Council's decisions and ruminations at the Mexico City meeting.

Other actions of Council were to appoint J. H. Rushton as a three-year representative to the Engineers' Council for Professional Development and to consider the appointment of a number of committee members to the same organization. Council also considered members of A.I.Ch.E. whose dues are unpaid; it will make a special attempt to reach these individuals and to see whether they cannot be salvaged for the professional organization.

An item of continuing consideration by Council was the growth of Local Sections, and the special problems arising from expansion of a section to the point where subsections or independent sections are spurting from it.

Council also accepted an invitation from the Delaware Valley Section (which incidentally had its name changed at that Council meeting from the Philadelphia-Wilmington Section) to meet in Philadelphia December 5 through 8, 1965. A careful look was also given at the financial statements of the A.I.Ch.E.

J. J. McKetta, chairman of a special Council subcommittee on member contribution to the Endowment Fund, reported to Council; and along the same line J. J. Healy, who is also working on the Endowment Fund, though in a different area, reported to the Executive Committee on his project, about which certain members will hear more in the future.

New members

Last month, too, I explained a few of the reasons back of our appeals for new members for A.I.Ch.E. This month a report comes in from Sam West, vice-chairman of the Membership Committee, that the first seven months of 1960 show the highest record to date—313 applications ahead of the year 1957, our best year until now. It is gratifying to note that a large proportion of these are from new graduates. These young engineers, many of whom have learned something of the work of the A.I.Ch.E. through their participation in Student Chapter activities, will enjoy throughout their careers the stimulation of membership in their professional society.

Check those classified ads!

Members of A.I.Ch.E. who do not take advantage of the classified section in CEP when they need it are missing a bet. Owing to a special technique developed by A.I.Ch.E., more than 600 inquiries from employers were processed in answer to the ads in the July issue. The value of A.I.Ch.E. members in the employment mart is



borne out by this figure. Any members who are unemployed are urgently reminded to give *Chemical Engineering Progress* a crack at their problem—as is any firm employing chemical engineers.

For posterity

At the cornerstone-laying ceremony of the United Engineering Center, which is expected to be completed next July, the contents of the cornerstone were records and insignia from the societies to be housed in the Center. The A.I.Ch.E. submitted its 1959 Annual Report and a history of the Institute. Although the A.I.Ch.E. drive has officially ended, contributions are still being forwarded by the Local Sections that renewed their solicitations, and of course the campaign will not actually be closed until every pledge has been realized. The generous response of the chemical engineers is a cause of pride, and we are only sorry that modesty forbade our enclosing in the cornerstone a small tribute of praise to ourselves for being the first society to meet its quota.

Never too soon to be professional!

A summary of a questionnaire of a different kind has recently been submitted by Matthew Van Winkle, chairman of the Subcommittee on Student Professional Attitude of the A.I.Ch.E. Professional Development Committee. A 55% return on a questionnaire submitted to the heads of chemical engineering departments throughout the country showed that 96% of those answering are actively attempting to improve the professional attitude of their students. Four departments, in fact, have required courses on ethics and professionalism. However, the method that was mentioned most often was "promoting and maintaining a strong A.I.Ch.E. Student Chapter." Other means are seminars, group discussions, outside speakers, and staff lectures. Of the junior and senior students, about 50% were considered to have a professional attitude, those with higher grades rating as more professional than the poorer students.

A question on the faculty, moreover, elicited the interesting information that more chemical engineering department members hold membership in the A.I.Ch.E. than hold engineering licenses (about 3 to 2).

Be specific!

And not to be outdone, we are issuing our own questionnaire, as most members know by now. This may seem a repetition of others you have



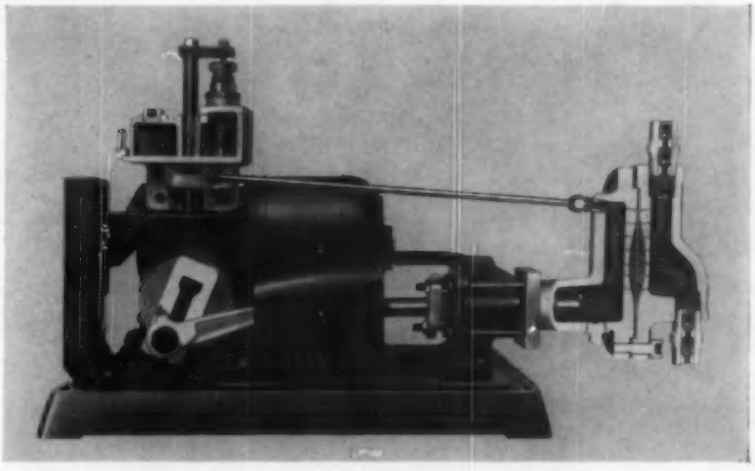
answered, but it is our only way of keeping our files up to date. Also, the question on special interests is of particular importance to you, as it is from these answers that we compile our mailing lists for special publications and meetings such as the heat transfer, automatic control, and nuclear engineering conferences.

F. J. V. A

how to meter corrosive liquids safely and accurately

THE problem of metering highly corrosive, toxic, or dangerous liquids can frequently be solved with a diaphragm type controlled volume pump. In this design, the plunger displaces a hydraulic fluid, which in turn moves the leakproof diaphragm to create pumping action through the ball checks.

Isolating the plunger and drive from the process fluid solves the corrosion problem, but it introduces another problem—air binding—that must be overcome to assure accurate, dependable metering. Milton Roy eliminates the air binding problem by automatically and mechanically venting the pump chamber once each stroke.



Cross-section of Milton Roy diaphragm pump shows how positive mechanical venting compensates for minor variables, eliminates air-binding.

Air binding

The plunger, or hydraulic side of the diaphragm is essentially a *closed* system. An air bubble caught in this system contracts and expands with each stroke, destroying accuracy in proportion to the change in air bubble size. This "air binding" effect can reduce pumping efficiency to the point where pumping actually ceases!



This complete kit lets you convert any Milton Roy packed plunger MD pump to a diaphragm liquid end pump.

But that can't happen with a Milton Roy pump. For a brief period during each cycle, the reservoir ball check opens while the plunger reciprocates through a fraction of an inch without diaphragm motion. During the suction portion of the stroke, hydraulic fluid flows into the pump chamber to make up any losses. During the discharge portion, any excess fluid or air present is forced out of the system. This positive mechanical action not only eliminates air binding, but compensates for any minor variables which may affect pumping accuracy. Milton Roy takes the further precaution of isolating the hydraulic fluid from the drive train. There are no gears, worms, or trunnions beating air into the fluid.

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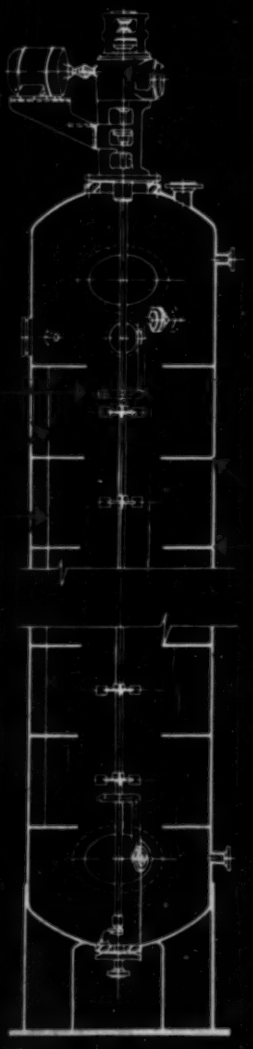
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